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ABSTRACT

The layouts and specifications provided are intended as a guide to school boards, educators, and architects. Drawings and room plans illustrate specifications for girls' occupational shop, graphic arts, carpentry (millwork and building construction shop), boys' occupational shop (mechanical), boys' occupational shop (building construction), machine shop, sheet metal shop, electronics laboratory, and electric shop. Refrigeration, air conditioning, and heating requirements for all shops are also provided. (Author/MLF)

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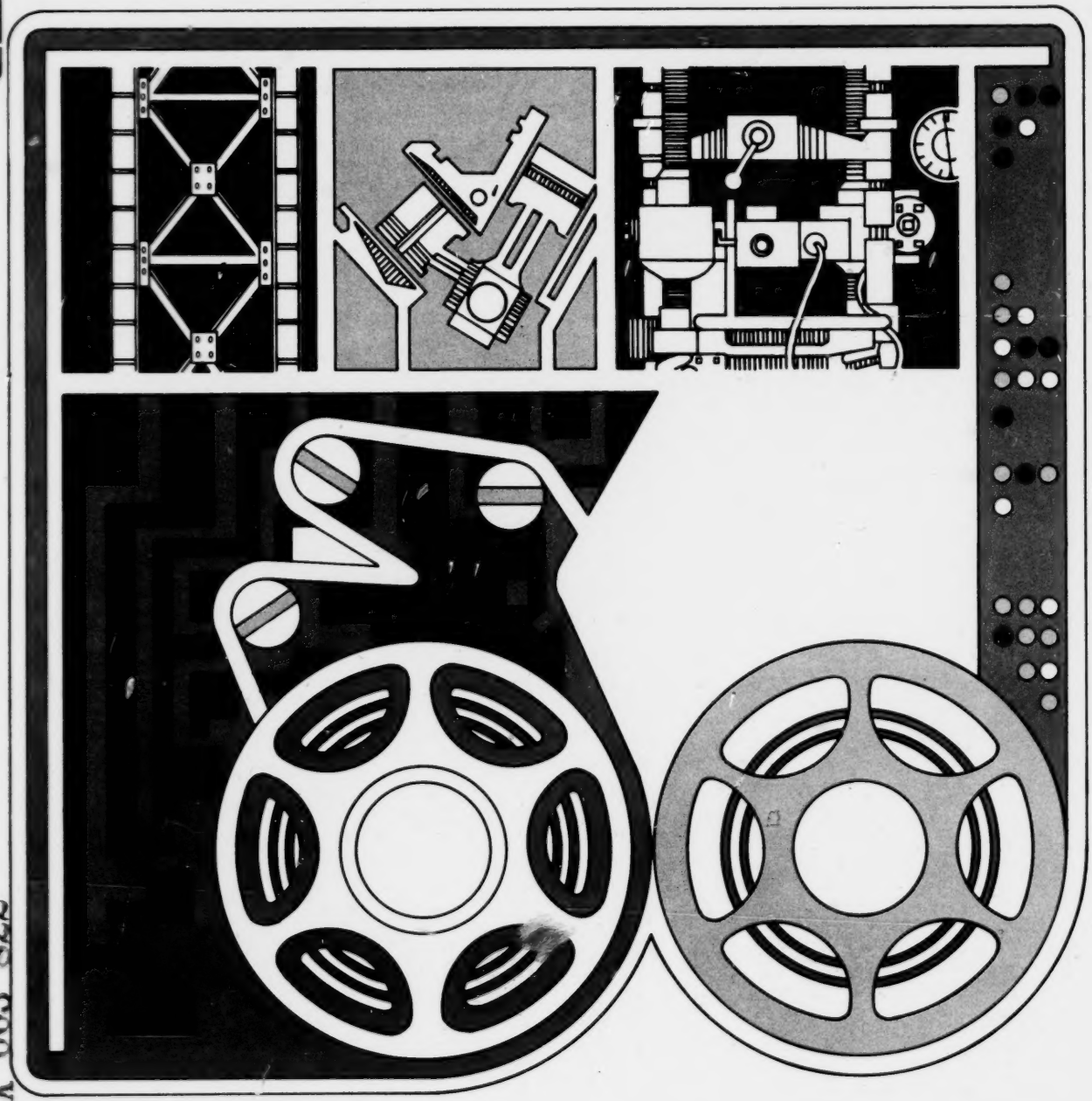
Ontario Department of Education

# TECHNICAL AND OCCUPATIONAL SHOPS

## Volume II



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Prepared by
SCHOOL PLANNING AND BUILDING RESEARCH SECTION
of the School Business Administration Branch

in conjunction with
the Curriculum Section

December 1969

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## PREFACE

The layouts and specifications for technical and occupational shops provided in this supplementary publication are intended only as a guide to school boards, educators and architects. The actual room shape and the physical arrangement of equipment are the prerogative of the architect and the local board.

The equipment shown provides for a wide variety of programs. The individual program, as determined by the school board, will establish the actual equipment to be purchased.

Some guidelines are needed, however, to help planners accommodate the basic aims of technical education. Adequate space and appropriate equipment are imperative in every design. Since the ratio of theory to practical work will vary from shop to shop and school to school, both should be given every consideration. Storage for consumable supplies and tool facilities which are easily accessible, yet carefully controlled, should also receive emphasis during the planning stage.

It is pointed out, however, that these shops, like those of the first publication were not planned with the Elements of Technology courses on an integrated basis in mind. To accommodate this more recent approach in technical education, maximum utilization of common facilities is desirable to provide every opportunity for reinforcement of related disciplines. Officials of new schools intending to offer the technologies should plan groupings of laboratories and shops rather than consider the individual unit approach outlined in this publication. On projects involving renovations or additions, the suggestions in the following pages will be of particular value.

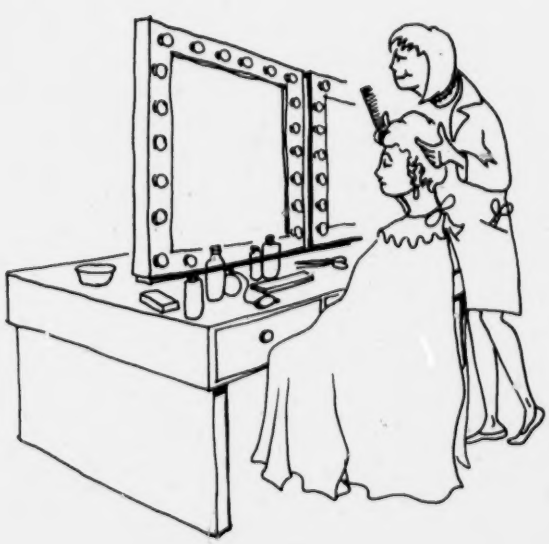
## GIRLS' OCCUPATIONAL SHOP

### FUNCTION

The aim of the occupational program is to educate students not only for employment but for personal, social and educational development, so that they may take their place as responsible, respected, contributing members of the community.

Since community opportunities vary greatly from place to place, shops should be set up to meet the requirements of local industry. A prerequisite to shop planning is an up-to-date, realistic occupational and industrial survey of local and surrounding areas. This survey should include consultation with businessmen to determine present needs and future trends in industry. To meet these changing requirements, shops should be flexible in design so that changes to new occupations may be implemented quickly with the least possible cost.

Shop planning should consider the needs, interests and abilities of students and should provide sufficient flexibility to permit the individual pupil to select courses that are most meaningful to her. Not all occupational shops should be built according to a preconceived plan. The plans offered here are merely a guide. Insight into the needs of students, an understanding of local conditions and an imaginative approach to planning will produce shops that will most adequately fulfill the aims of this course in each community.



### LOCATION

An important aim of the occupational program is to help students who have experienced academic failure to gain confidence and improve their self-concept. The location of the occupational shop in a prominent position in the main area of the school will do much to achieve this aim. When occupational shops are added to existing buildings, they should not be relegated to an obscure corner out of the mainstream of activity.

Because the girls' occupational shops frequently include areas for retailing and restaurant services where teachers and students may go to make purchases at lunch time or after school, it is good planning to locate the room near an exit to the outside of the building to avoid undue commotion in the corridors when other classes are in progress.

Occupational students generally respond positively to bright, cheerful surroundings. Whenever possible the room should be located on an outside wall to provide adequate window area.

### FACILITIES

The girls' occupational shop is a multi-purpose room, set up to include several areas such as hairdressing, retailing, sewing, arts and crafts, hospital services, and home management. However, too many different activities in one room should be avoided. Where many different activities are offered, two rooms or a divided room, would be preferable. A shop offering

three or four areas and accommodating 12 to 15 girls would require 1,800 to 2,000 sq ft of area.

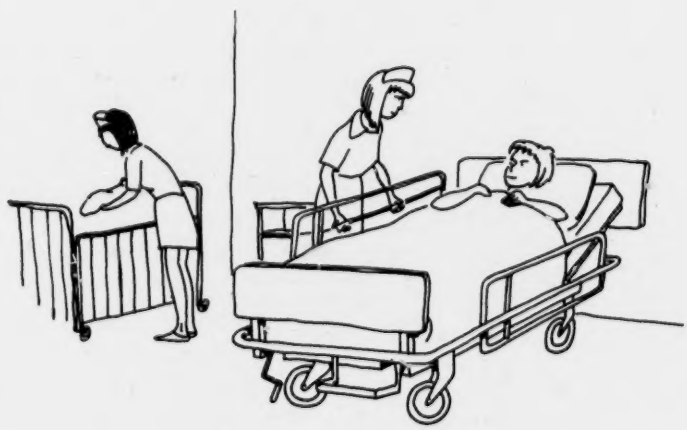
Since, in a girls' shop, it is often necessary to have several activities operating concurrently because no one area is large enough to accommodate the entire class, each area in the room should be as open as possible. Where divisions are necessary, partitions should be low so that the entire classroom is in full view of the teacher at all times.

Hairdressing: This area should be equipped with at least two shampoo sinks and four or five hair dryers. Counters should be arborite with at least one stainless steel sink. Storage cupboards should be equipped with locks.

Retailing: Basic retailing installations should include a locked storage cupboard for stock, a counter for cash register practice and selling area and adequate display areas. Shelving should be adjustable for the greatest possible flexibility.

Home Care: This area should be equipped with stainless steel sinks, plastic laminate counters and adequate storage space.

All other areas require locked storage facilities Equipment should be moveable and adaptable to changing requirements of the course. Tables used in the teaching area could be flexible in design so that they can be converted into display tables, work tables or cutting tables.



## FINISHES

Because of the wide variety of activities carried on in a girls' occupational shop, a tile floor that is easily cleaned is recommended. Stainless steel sinks and arborite counters are most suitable. All available wall space can be utilized for tack board or bulletin board.

## STORAGE

In addition to locked storage cupboards in each area, shelves for books, pamphlets and periodicals are required. A coat cupboard for storing uniforms is also desirable.

## LIGHTING

It is important that the room have adequate lighting, suitable for close work such as sewing or other handwork.

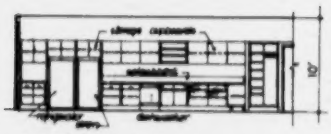
## SERVICES

Each area requires several electrical outlets for appliances, sterilizers, and other equipment. The hairdressing area will need special heavy duty electrical wiring to accommodate the hair dryers.

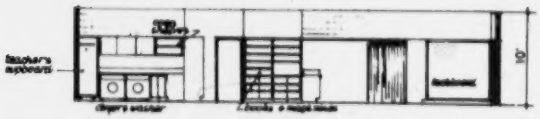
## VENTILATION

Ventilation is an important factor in planning a girls' occupational shop, because of the various activities. The laundry creates moisture and heat, the hair dryers also heat up the room, while the cooking areas create other problems of ventilation. All of these factors should be considered carefully in planning the window areas and placement of ventilation facilities and fans.

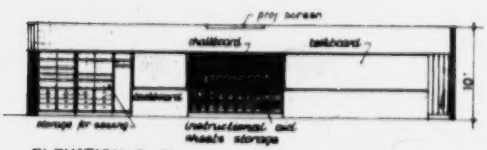
# Occupational Room for Girls (1)



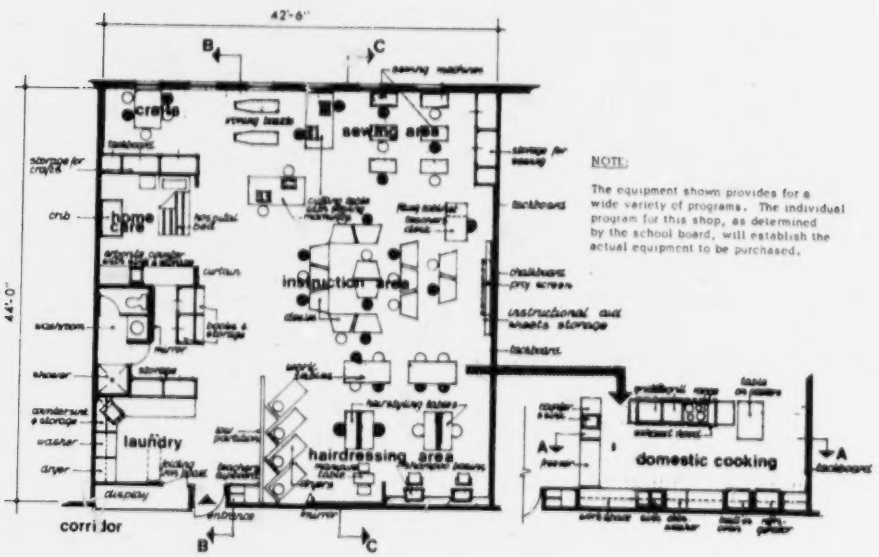
ELEVATION A-A



ELEVATION B-B



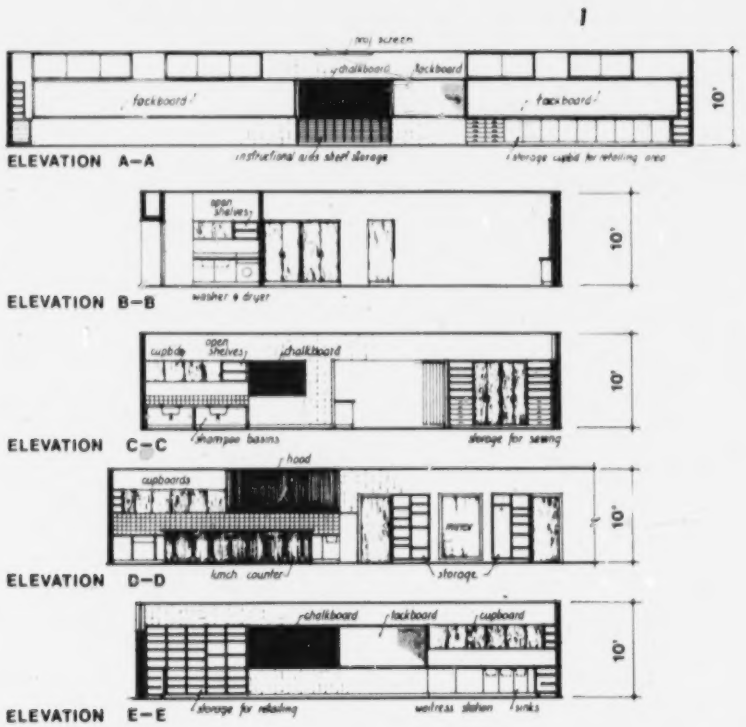
ELEVATION C-C

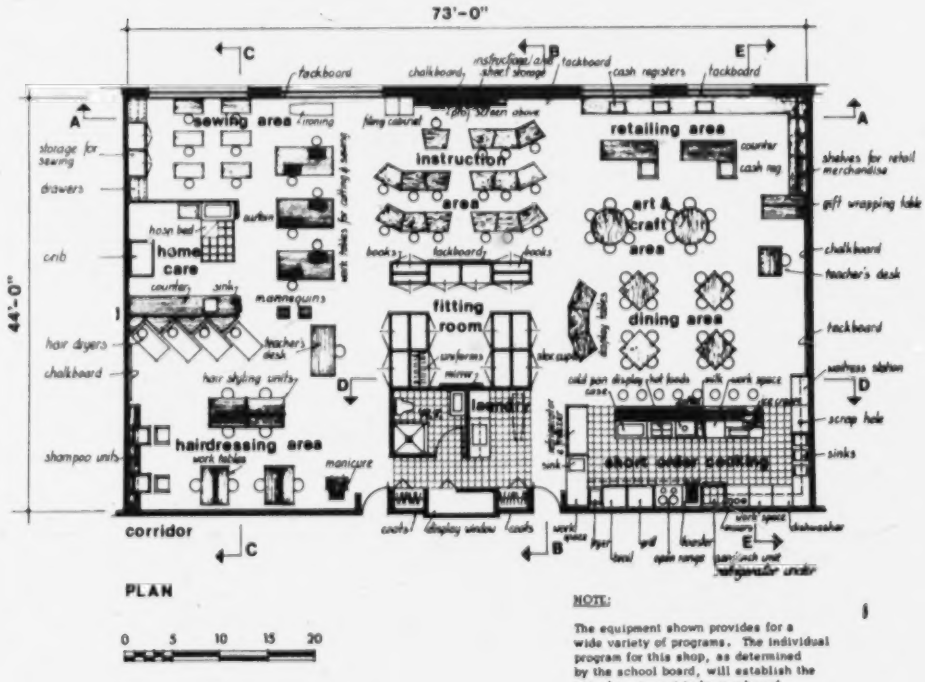



PLAN

ALTERNATIVE

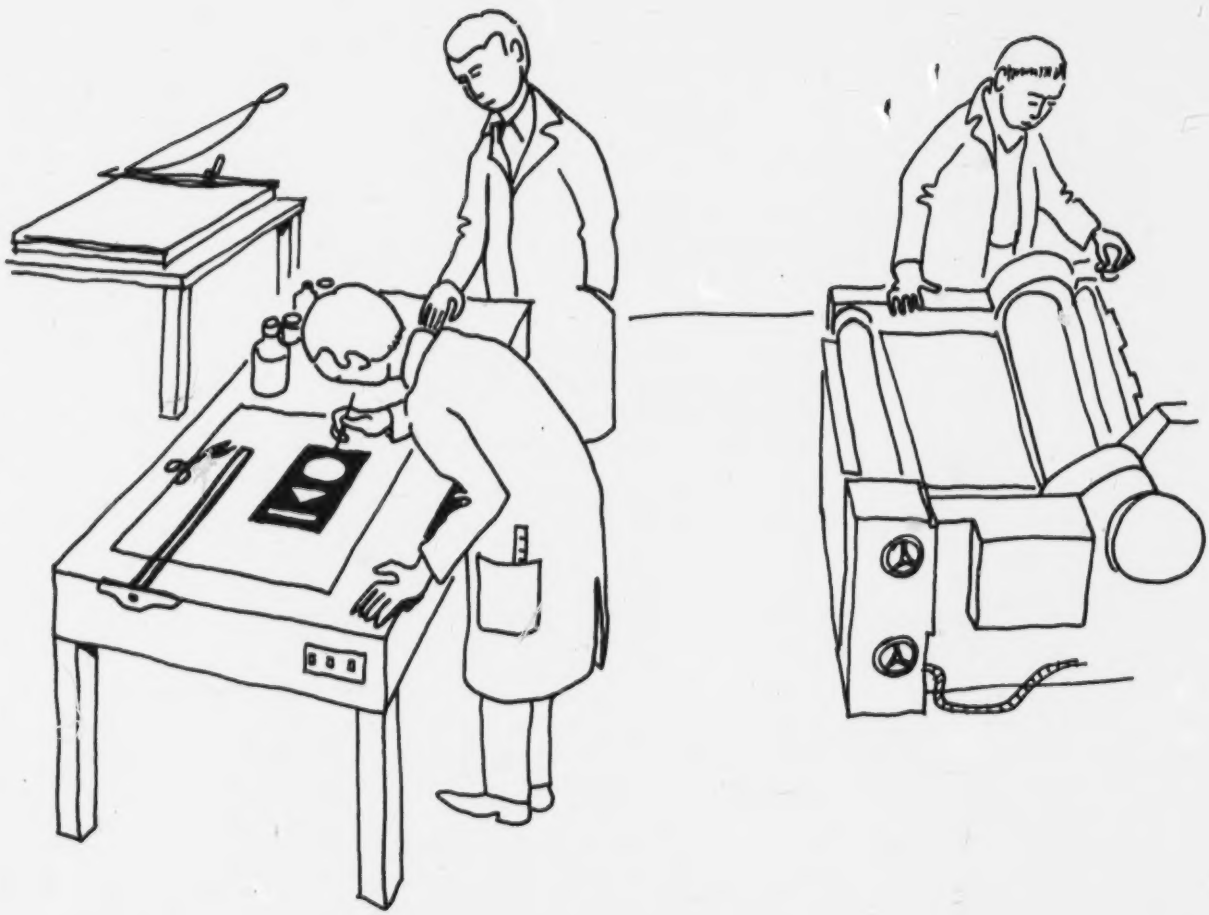
# Occupational Room for Girls - Two Groups (1A)




NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.



## GRAPHIC ARTS SHOP

### FUNCTION

The graphic arts shop provides facilities for theoretical instruction and practical application of all facets of the graphic arts industry. There is great emphasis placed on the basic concepts of printing as well as the "to-do" aspects. The instruction covers the entire spectrum from the history of printing to the latest, most sophisticated application of the trade.

Graduates with a good standing may apply for admission to the Ryerson Polytechnical Institute for their management program in graphic arts or to a College of Applied Arts and Technology.

Opportunities for employment are many. Graduates, as registered apprentices, are constantly sought by industry.

The layout provides space and work stations for 20 students.

### LOCATION

Because of the nature of the equipment, i.e. weight and bulk size, the graphic arts shop should be located preferably on the ground floor of the school building. There are fumes generated from the hot metal machines. Adequate ventilation must be provided because many processes involve the use of chemicals and chemical solutions.

### FACILITIES

The area of the graphic arts shop layout is approximately 2,800 sq ft. This will include the teaching area, storage facilities, camera and dark rooms, and the area for type casting. Some may prefer to have the type casting area enclosed and special exhaust fans provided for it independently; a glazed partition is advisable for easier supervision.

### FINISHES

A floor of non-slip tiles or non-slip concrete would be suitable. Walls of concrete blocks should have a durable finish for easy maintenance.

### LIGHTING

Windows can be installed not lower than 7 ft above the floor, not to interfere with placing of equipment, work benches, etc. Black-out curtains should be considered for the teaching area for the use of projection equipment.

Fluorescent lighting is recommended as general lighting. The rated illumination should be not less than 85 ft candles at the working level.

Safety lighting is required for the darkroom areas.

### SERVICES

The electrical power must be 110/208v, three-phase, four-wire system with a 400 amp (minimum) capacity. A circuit breaker should be provided with each machine. Supply control and distribution should be located adjacent to the main door, with emergency controls located at strategic points in the rooms.

Electrical outlets of 110v should be placed close to work areas for electric timers, camera lamp, light tables and other equipment peculiar to graphic arts shops. Outlets for audio-visual equipment must also be provided.

Water: Hot and cold water will be needed for the darkroom and for washing facilities. Containers for soap and paper towels should be provided in the wash-up area and the darkroom.

Gas: Gas is required if gas-fired heating equipment is used for type casting.

Air: Compressed air is required as a cooling agent for the linotype machine.

## HEATING AND VENTILATION

Refer to the general discussion concerning heating and ventilating shops. This information is available under common facilities heading.

## STORAGE

Adjustable shelving and cupboards are a necessity for chemicals, paper, ink, plates, film, and the supplies required for the operation of a graphic arts shop. Storage should be provided for the students' projects.

## CHALK AND TACKBOARDS

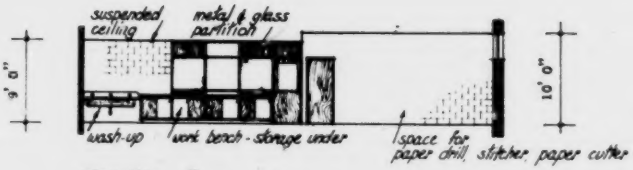
In the teaching area approximately 20 linear ft of chalkboard should be provided.

Portable tackboards, panels for exhibition of posters, teaching aids and illustrations, as indicated in the drawing are useful for screening off the teaching area.

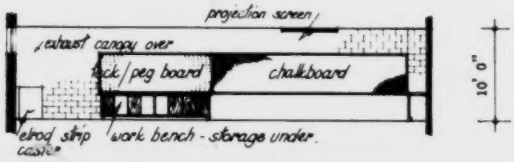
## SCREEN

A pull-down tilted projection screen should be installed above the chalkboard in the teaching area.

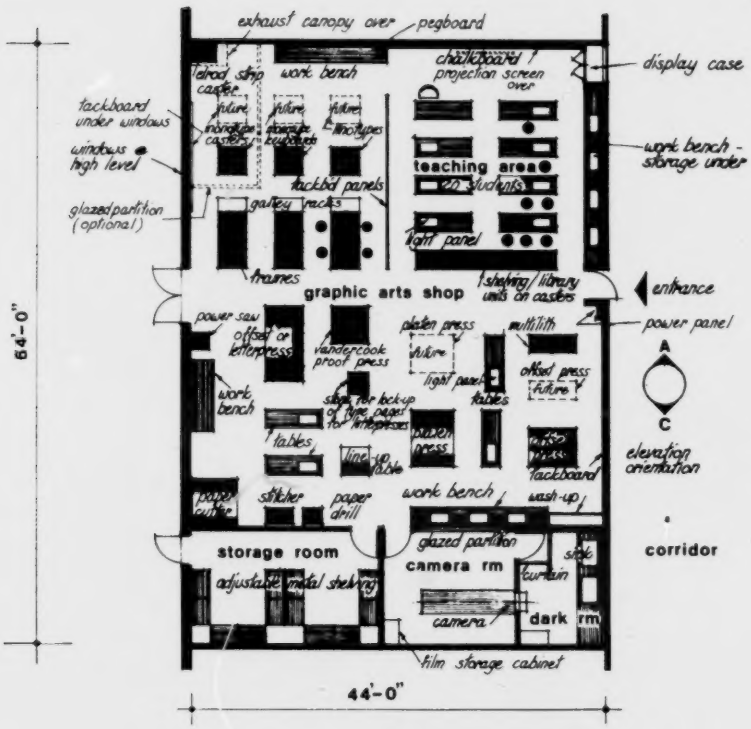
# Graphic Arts Shop (2)




elevation C




elevation A




NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.

## CARPENTRY-MILLWORK AND BUILDING CONSTRUCTION SHOP

### FUNCTION

The carpentry shop has been designed to permit optimum teaching of a basic intermediate course in woodworking and to provide coverage in depth of construction principles and techniques at the senior levels.

The suggestions made in the text and the ideas shown in the drawings are intended to stimulate thought and promote discussion. Emphasis has been placed on good design and equipment. The plan shown makes provision for 20 pupils.

### LOCATION

The shop should be isolated from academic areas because of a high noise level created by some of the heavier machines. The provision of a large level area approximately 60 x 100 ft immediately outside the shop would make possible the erection of a more substantial building than could be built on the open area within the shop.

### FACILITIES

The area (which includes the classroom) of the building construction shop is approximately 3,080 sq ft. The large open floor area 24 x 24 ft has been kept free of machines to permit the instructor to plan his senior course around a full-size project which can be erected, then taken down, and transported through the overhead door.

The separate classroom area provides an excellent environment for formal instruction as well as a quiet clean atmosphere for individual study and research. Resource material such as reference texts, film strips, and other learning aids may be concentrated in this room. Machines have been arranged to permit easy flow of material from storage rack to finished product. The work benches have a two in. birch or laminated maple tops and permit the storage of small projects underneath.

It is suggested that machine location be shown in the building contract drawings.

### STORAGE

For storage of lumber and plywood, a storage room with racks and space for a cut-off saw should be provided. A seven ft ceiling will allow space to store students' projects on the mezzanine. A metal cabinet designed to meet safety regulations for storage of paint and lacquer should be provided.

Lockable storage cupboards near the woodworking benches should contain adjustable shelving and racks for tools and should be planned by the architect and the technical director jointly.

A work-counter, 40 to 42 in. high provides excellent assembly space for students' projects, gluing, tool-sharpening, etc. One-half the length of the work-counter should be equipped with adjustable shelves and lockable doors for storage, the remaining part with open shelving. Chalkboard and tackboard should be placed over work-counter.

### FINISHES

Floors: In the shop's building construction area where such work as concrete pouring, trowelling, mixing of mortar and brickwork will take place, a concrete floor should be provided. This floor should slope to a floor drain; a catch basin should be provided.

The floor for the remaining part of the shop can also be concrete, but a wood composition on concrete is preferable with non-skid provision in machine operation areas.

In the classroom, a wood or vinyl asbestos floor is recommended.

Walls: Concrete block walls are suitable, but they should be finished with enamel, epoxy paint or ceramic spray for maintenance purposes. The partition between classroom and shop can be of hollow metal construction, but attention should be given to suitable sound insulation.

Ceilings: Although this will be a noisy shop, the installation of a ceiling can hardly be justified. Spraying asbestos fibres or similar on the underside of the roof slab or deck will help to eliminate part of the noise.

In the classroom a suspended acoustic tile ceiling is desirable.

LIGHTING

Windows should be a minimum of seven ft from the floor to permit use of all available wall space for cupboards, display shelves, and storage. Fluorescent fixtures must ensure 85 ft candles for general lighting.

SERVICES

A main power panel should be provided at the entrance door (pilot lights). The electrical power should be a 120/208v, three-phase, four-wire system with a 200 amp capacity. Circuit breakers should be provided for each machine. Ample electrical outlets of 110v should be placed convenient to work stations for the use of portable power tools. Outlets will also be necessary for a slide projector, a portable tv, an overhead projector and other teaching aids. Panic buttons should be located at strategic points in the shop.

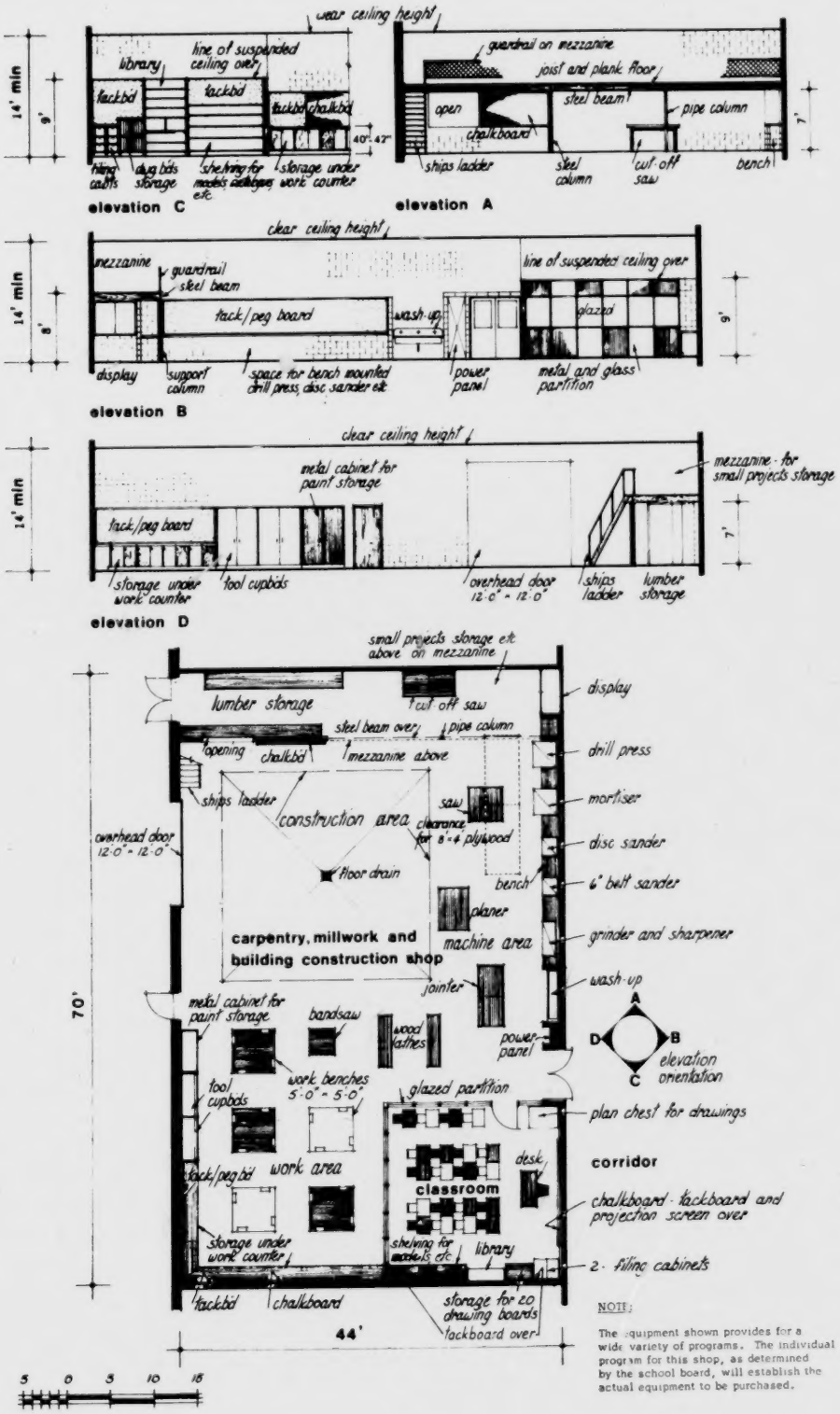
Water: Hot and cold water will be needed for the wash basin.

Air: Compressed air from the school's central system is required for three outlets equipped with quick couplers.

VENTILATION

The ventilation system must be balanced to take care of the exhaust sytem which is required for power tools such as planer, jointer, table saws and sander.

# Carpentry, Millwork and Building Construction Shop (4)



## BOYS' OCCUPATIONAL SHOP (MECHANICAL)

### FUNCTION

The boys' occupational shop, designed to accommodate a maximum of 16 students, should lead to many employment opportunities. Three areas of instruction are recommended, all illustrated in the shop plan: service station operation, sheet metal, and welding. These areas are merely suggestions. Substitutions would be encouraged where circumstances dictate. For example, small engines would be better subjects of study than sheet metal in a resort area where students are familiar with outboard motors and power-saws.

### LOCATION

The work in this shop may be noisy and for this reason it should be placed far enough from the academic wing of the school to avoid interference.

### FACILITIES

The area of the layout in drawing 7 is approximately 2,400 sq ft in order to accommodate the tools, supplies, and space needed for all three subject areas. Since space will still be at a premium, it is suggested that the work benches be used for seat work as well. Stacking stools and moveable benches provide extra room when required. A library cupboard with glass doors should be located near this area.

An efficient exhaust system is also needed in the welding area, as the fumes from both types of welding are toxic. This will require extra attention to heating requirements due to the volume of heated air being removed.

The two overhead garage doors should be large enough for cars to enter the shop directly at the wash or hoist area. The sectional doors should be insulated and have automatic controls to turn the auxiliary heaters on in cold weather when the doors are open.

Only one hoist is necessary in this shop and a minimum of 12 ft free height is essential to accommodate the extended hoist with a car on it. A drain will be required under the hoist to remove water which might interfere with the operation of the hoist.

A 100 gal capacity underground oil tank is suggested outside the building to receive oil from the changer. An opening will be required for removal of the waste when the tank is full.

In the welding area, it is suggested that each welding booth have an equipment board on the wall to store helmets, hammers, wire brushes, gloves and aprons. The booths should be constructed as those detailed for the welding shop in this brochure. Safety glass must be used if a window is desired in the side panel. Asbestos curtains of sufficient size are required in the doorways to avoid the danger of flash burns to those students occupied with other work and not wearing helmets. A sprinkler system is desirable in the welding area. Oxygen and acetylene tank storage in separate enclosed rooms must conform to the National Building Code and the requirements of the local fire marshal.

A sales office of approximately 100 sq ft should be located close to the overhead door where cars come in to be serviced.

Students should be located at this office on shift to learn about the kind of work a service manager does when dealing with customers in a service station or in a repair garage.

It is advisable to have a show window between the shop and the sales office, as well as display shelves in the office. A sales counter is recommended with a cash register and space to fill out repair slips and bills as well as for bookkeeping. A tackboard on one wall is practical for displaying charts of motor parts and equipment. A mezzanine floor for storage can be erected above the sales office, but the ceiling height on this layout does not allow a person to stand upright.

FINISHES

Floor: A hardened concrete floor is required, preferably natural colour. Care is needed to ensure proper slope for drainage, particularly in the car wash area where a combined drain and heater for melting ice and snow is needed. All drains should be equipped with grease and sand traps.

Walls: Concrete block construction is adequate. A hard-wearing surface is needed on the interior walls for ease of maintenance.

Ceiling: No special finish is required. There may be exposed joints, steel beams, etc.

LIGHTING

The National Building Code should be followed for fluorescent fixtures. Furthermore, three complete rewind extension reels for handlamps should be provided, connected to electrical services.

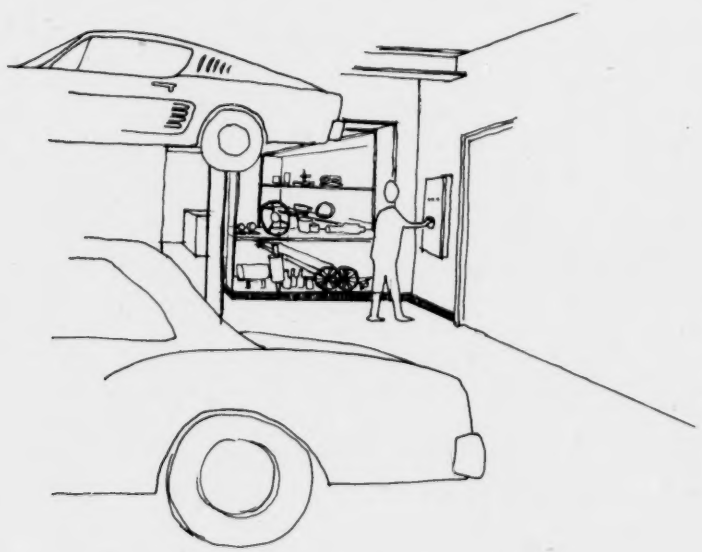
SERVICES

Electrical: An electric main power panel should be located beside the door to this shop. The service required is 120/208v, three-phase, four-wire system with a 400 amp capacity. Circuit breakers are needed for each welding machine.

Regularly spaced 110v electrical outlets with water-proof covers are required around the room.

Water: Supplies are needed for Tungsten Inert Gas units and spot welders. A hot and cold mixing valve is needed in the car wash area, at the wash-up area, and in the washroom beside the sales office.

Air: Compressed air is needed in both the welding and auto services areas. For acoustical reasons it is preferable to have a centralized system with the compressor located in the boiler room for air supply to all the shops in the school. The air requirement is 150 psi with a capacity



of 75 cu ft/min. This will take care of the spark plug cleaner, hoist, degreasing tank and the cutting table in the welding area.

Natural Gas: Will be required for soldering.

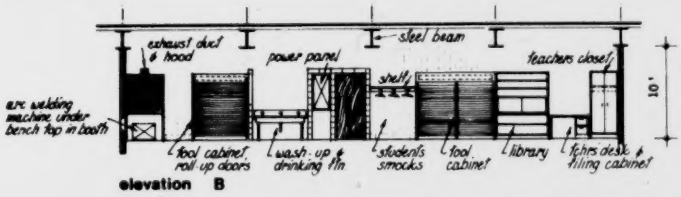
GENERAL

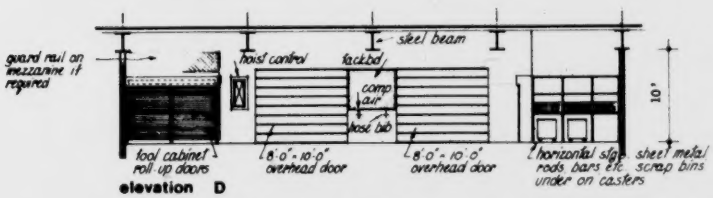
A lockable metal tool cupboard 7 ft high and 2 ft deep with adjustable steel shelves is necessary for the more valuable tools.

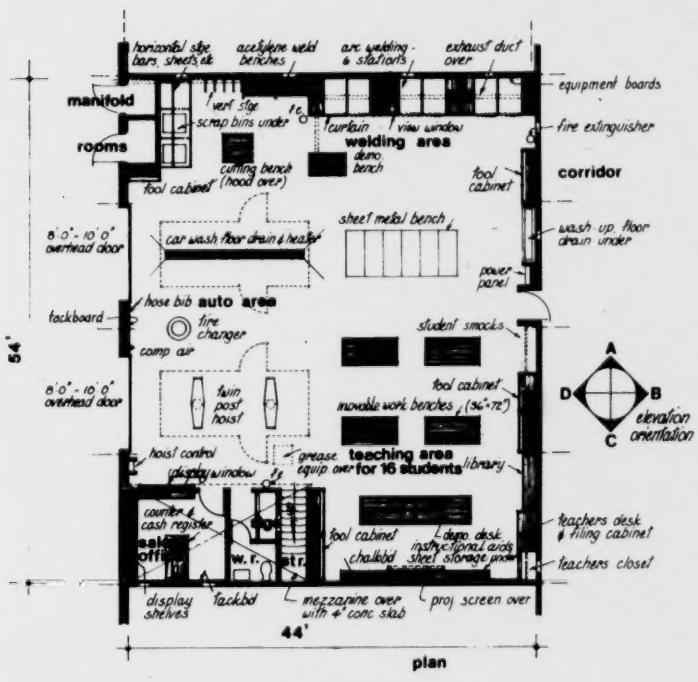
Other tools should be stored efficiently, as shown on the drawing, in cabinets, on pegboards, and on racks to make checking simple and to teach organization.

Fire extinguishers should be stationed at convenient points in the shop as shown on the drawing, two in the welding area and one in the auto repair area.

# Occupational Shop for Boys (7)



NOTE:

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## BOYS' OCCUPATIONAL SHOP (BUILDING CONSTRUCTION)

### FUNCTION

Building construction is a combination of carpentry, painting, decorating, and trowel trades. It is hoped that students will acquire an interest in the construction industry and a desire to work in one particular field. In some areas substitutions are encouraged if they are to the benefit of the student. For example, students in a resort area might find boat-building or boat-repair useful subjects.

### FACILITIES

A floor area of approximately 2,400 sq ft can be organized to leave a space large enough for construction of a 20 x 24 ft structure.

The room is designed to accommodate a maximum of 16 students if all available space is used. The work benches, for example, can be used for both theory and practical work. It is preferable, also, for these benches to be moveable.

An efficient exhaust system is required for the removal of dust and paint fumes. The motor for this system should be mounted outside the building so that the operating noise interferes as little as possible with teaching.

An overhead garage door is needed for the delivery of supplies and for the removal of large, completed projects.

The exhaust system and the garage door will cause heating problems which require the attention of a heating expert.

Particular attention will have to be paid to the floor drains which are necessary in the trowel trades area. A sump pit will have to be made for the removal of foreign materials from the water, such as sand, gypsum, and cement, so that there is no danger of the drainage system becoming plugged.

A concrete pad approximately 30 x 30 ft on the driveway outside the door is also useful for construction work in good weather. A double electrical outlet with a waterproof cover placed as close as possible to the door could be used to operate the electric cement mixer and other power tools. To avoid vandalism, it is advisable to have this outside construction area fenced.

Small rooms or cubicles are needed for practice in painting and decorating. Each one should have a window and door and be equipped with a ceiling light, wall switch, and at least one outlet.

### FINISHES

Floor: A hardened concrete floor in a natural colour is needed for trowel trade, painting and decorating work. Floors should slope towards the drain indicated on the drawing. The floor in the building construction area should be either a good grade of tile with a waterproof adhesive or a hardwood with adequate protection from the water used in this shop.

Walls: Concrete blocks, or a similar material, with hard-wearing surface for easy maintenance are suitable for the interior.

Ceiling: No special finish is required.

### LIGHTING

Windows should be at least seven ft from the floor to avoid interfering with storage and work space.

An illumination level of 70 ft candles at the floor is sufficient.

SERVICES

Electric: The power panel should be located beside the hall door. It is also advisable to have panic buttons on each wall in case of emergency. The electric service required is 120/208v, three-phase, four-wire system with a 400 amp capacity with circuit breakers for each machine. Regularly spaced, grounded 110v electrical outlets equipped with water-proof covers are required around the room. A 10 ft spacing is suggested.

Water: Hot and cold mixing valves are needed in the utility sink and the wash-up sink. Cold water is needed in the trowel trades area.

Compressed Air: This is not essential but would be useful for cleaning the machines.

GENERAL

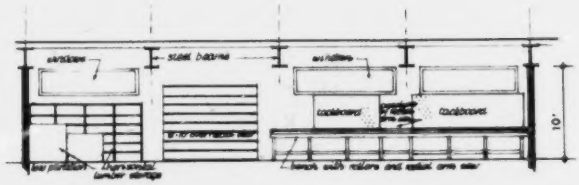
A steel cupboard with locking doors is required for paint storage.

Fire extinguishers should be provided in accordance with the Fire Marshal's requirements.

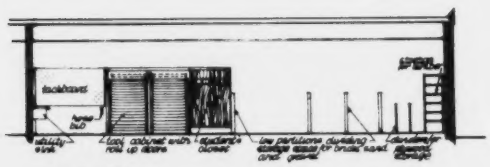
Interior storage is needed for sand, gravel, bricks, blocks, lumber, and plywood.

As a safety measure, all power machines should be equipped with magnetic instead of toggle switches.

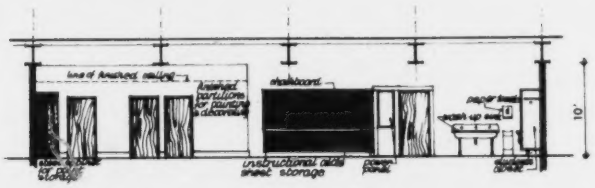
## Occupational Shop for Boys (8)



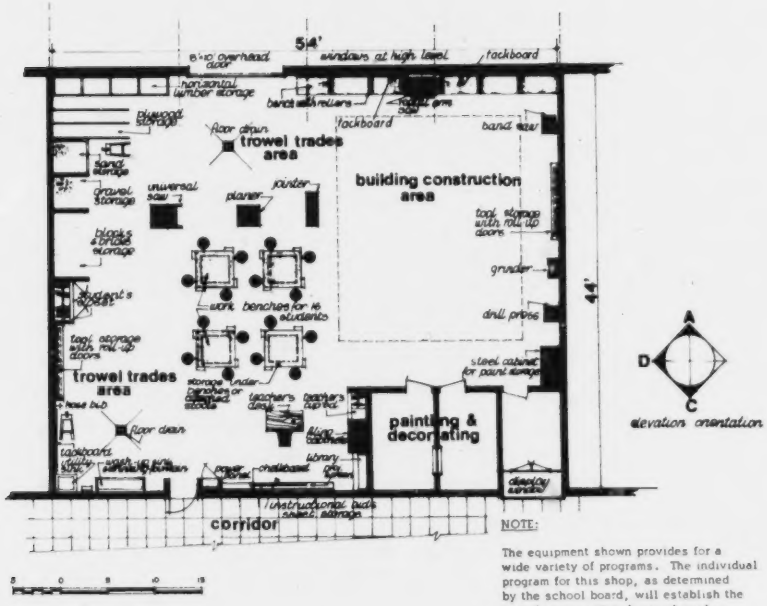
elevation A



elevation D



elevation C




elevation orientation

NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.

## MACHINE SHOP

### FUNCTION

Machine shop practice relates directly to machining and allied processes that the student may encounter in industry. It also provides excellent information for the student who wishes to pursue an engineering career.

The description and drawings of the machine shops are supplied as guides rather than as standard layouts. Work-stations are provided for 20 students.

Wherever possible, it is desirable to plan the teaching area within the shops. If two machine shops are adjacent, the heat-treatment area, classroom, and inspection area can be common to both shops.

### LOCATION

Because of the noise factor and the nature of the equipment, the shops should be located on grade level away from academic or study areas, with direct access to a driveway for deliveries.

### FACILITIES

Drawing 9: The area of this machine shop is approximately 2,280 sq ft, including the test room of 110 sq ft. The students' lecture area is a part of the open space in the shop. The lecture tables, each for five students, are used for layouts as well as work benches.

Drawing 9A: The machine shop in this layout is approximately 2,225 sq ft. This includes the areas of the testing room approximately 135 sq ft and half the 480 sq ft enclosed classroom which is expected to be shared by two or more shops.

Drawings 9B & 9C: Both layouts are alternatives designed for a larger school where two machine shops are required and, as shown, built side by side. In this case, the classroom, the testing room, and the heat-treatment area will be shared. The area of machine shop 9B, which includes half the area of the testing room, classroom, and heat-treatment area, is approximately 2,080 sq ft. The area of Plan 9C is approximately 1,940 sq ft, which includes, as mentioned for Plan 9B, half the common rooms for both shops.

The enclosed test-inspection areas provide a relatively dust-free and temperature-controlled atmosphere, with space for the storage of precision measuring instruments, test devices, and optical comparator.

Storage space should also be provided for student projects and work in progress. It could be designed so that each class is assigned its own compartment which can be locked.

The heat-treatment area groups the furnaces under a common ventilation-exhaust hood.

The arrangements of the 20 student-spaces may be used as illustrated, or may be changed to suit the general room configuration. The fixed-bench study area may be replaced by conventional student seats.

It is suggested that equipment be placed in a pattern that will permit observation of machining demonstrations by small groups of students.

### CLASSROOM

Because the machine shop is noisy and dusty, a separate enclosed classroom is recommended for instruction and study. The partition can be of hollow-metal construction, but attention should be given to suitable sound-insulation.

This room may contain a teacher's desk, a built-in or a separate unit, magazine rack, and some book-storage space. A legal-size filing cabinet for illustrations and reference material, etc., can be built into the teacher's desk. A few study carrels, if the space can be provided are desirable.

A chalkboard 14 to 16 ft long with instructional aids sheet storage underneath should be provided, under a pull-down projection-screen recessed

in the ceiling. One or two portable demonstration tables or units approximately 20 x 30 x 36 in. may be provided for demonstration of tools, work, etc.

FINISHES

Floors: A polished concrete floor with iron oxide hardener is suitable. It should be sealed to minimize dust formation and coolant penetration. Non-skid surfacing should be provided for the operator at each machine. Gas lines, electrical conduit, water, drains, and compressed air lines will all be required. Colouring is optional.

Walls: Glazed wall tile or concrete blocks are recommended. Blocks should be sealed and painted with low gloss enamel or epoxy paint for ease of maintenance. If the machine shop is adjacent to classrooms or other technical areas where the noise factor is significant, the walls should be treated with suitable acoustic materials.

Ceiling: Where classrooms are provided, suspended acoustic tiles should be installed at about nine ft in height. Wiring, ducts, etc., can then be concealed. Free ceiling height of machine shops should not be less than 10 ft.

## STORAGE

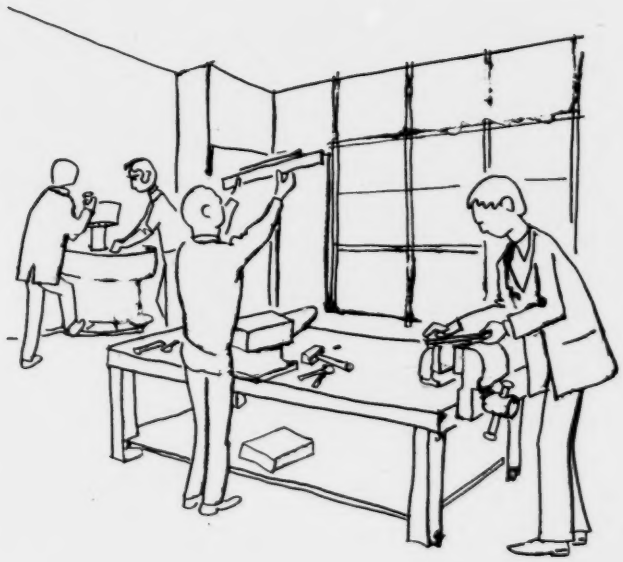
There should be both exposed and concealed tool-storage facilities. These storage areas are required for tools, projects, and materials in the main shop. In addition, suitable storage shelves are necessary in the test room.

## LIGHTING

Windows may be installed lower than seven ft above the floor.

Fluorescent lighting is recommended. The rated illumination should be not less than 85 ft candles.

Individual lighting is provided on most machines. Adequate receptacles must be provided for this purpose and should be arranged on advice from the technical director when the shops are planned.



## SERVICES

The electrical power must be 110/208v, three-phase, nine-wire system with 400 amp (minimum) capacity. A circuit breaker should be provided with each machine. Supply-control and distribution panel should be located adjacent to the main door. Emergency controls should be located at strategic points in the shop.

Electrical outlets of 110v should be placed close to work areas for portable tools and for audio-visual equipment.

Water: Hot and cold water will be needed for washing facilities and for a drinking fountain. Containers for soap and paper towels should be provided at the wash basin.

Gas: Outlets will be required for gas-fired, heat-treatment equipment.

Air: It would be desirable to have a perimeter installation of compressed air from the school's central system. The number and location of these outlets can be determined by the architect on advice from the technical director or consultant.

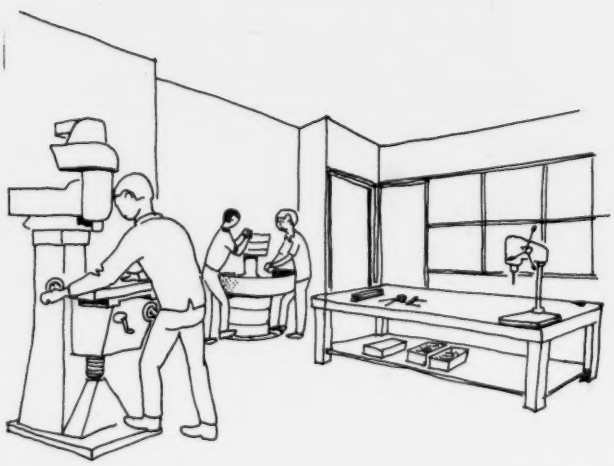
## HEATING AND VENTILATION

Refer to the general discussion concerning the heating and ventilation of a machine shop. This information is available under "Common Facilities"

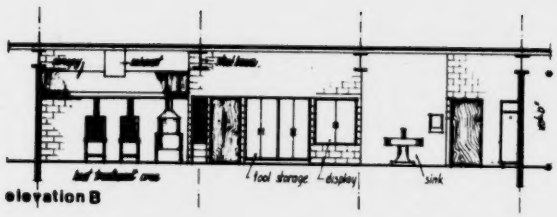
Proper ventilation and exhaust is most important in the heat-treatment area. Carbon-monoxide spillage may be a hazard if the room lacks an adequate exhaust system.

## DISPLAY

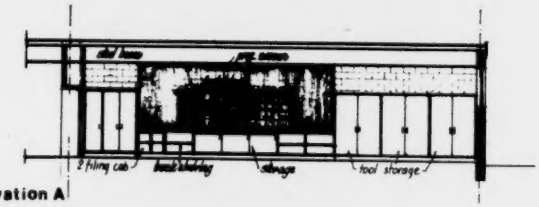
A display window in the corridor for the exhibition of students' work done in the shop is highly recommended.



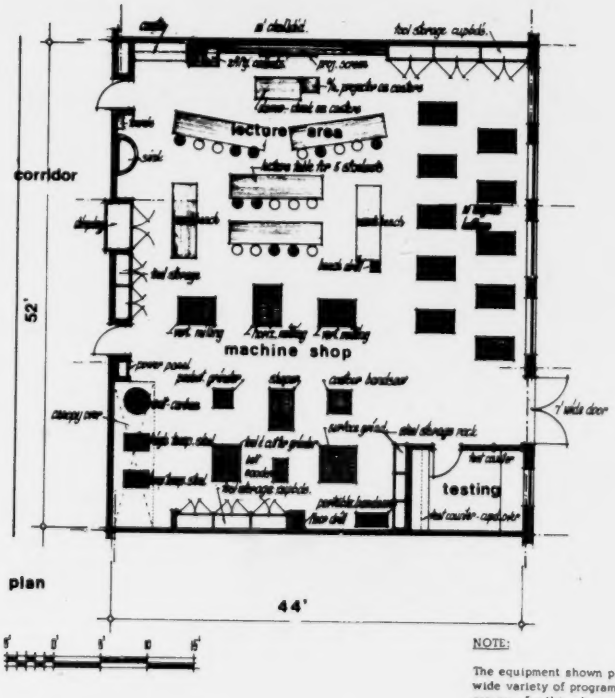
## Machine Shop (9)




elevation B




elevation A




plan

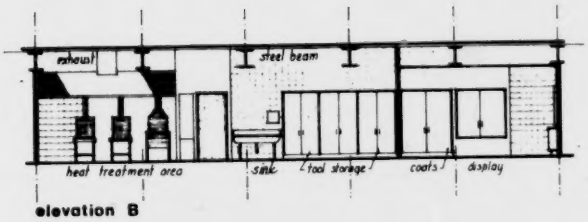
NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.

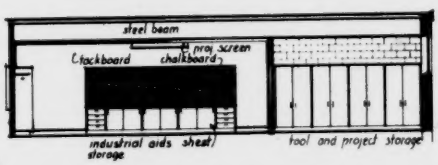
# Machine Shop (9A)

NOTE:

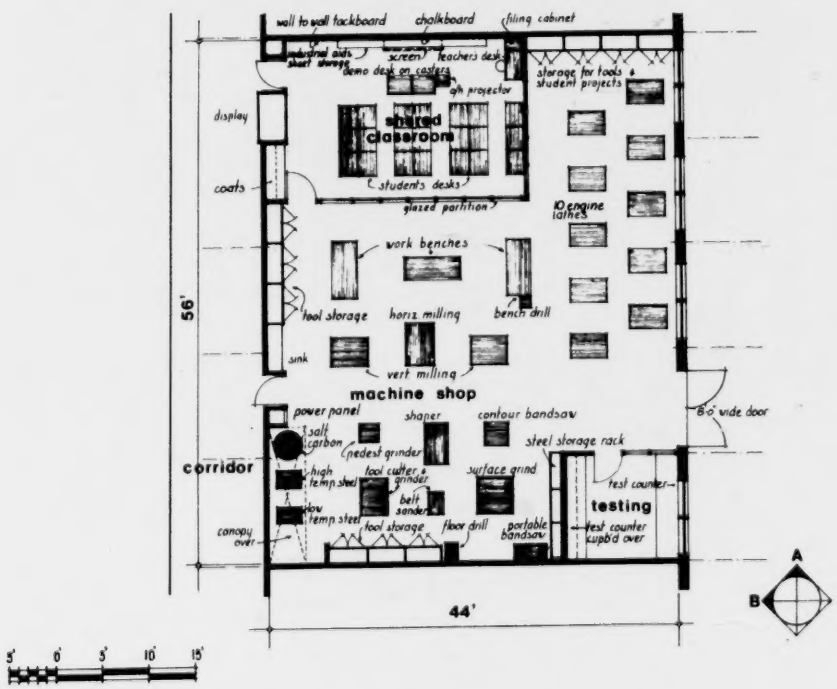
The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.



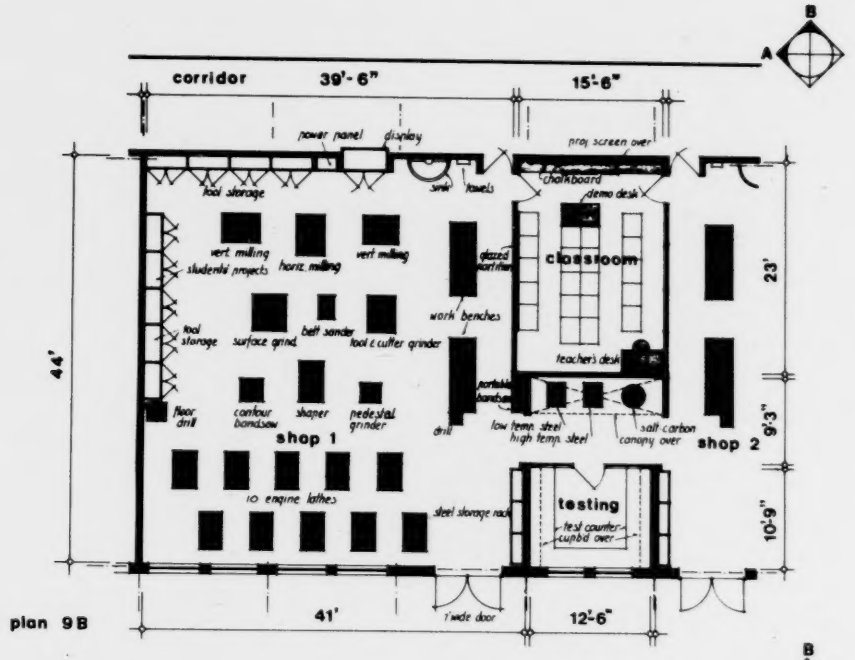

elevation B

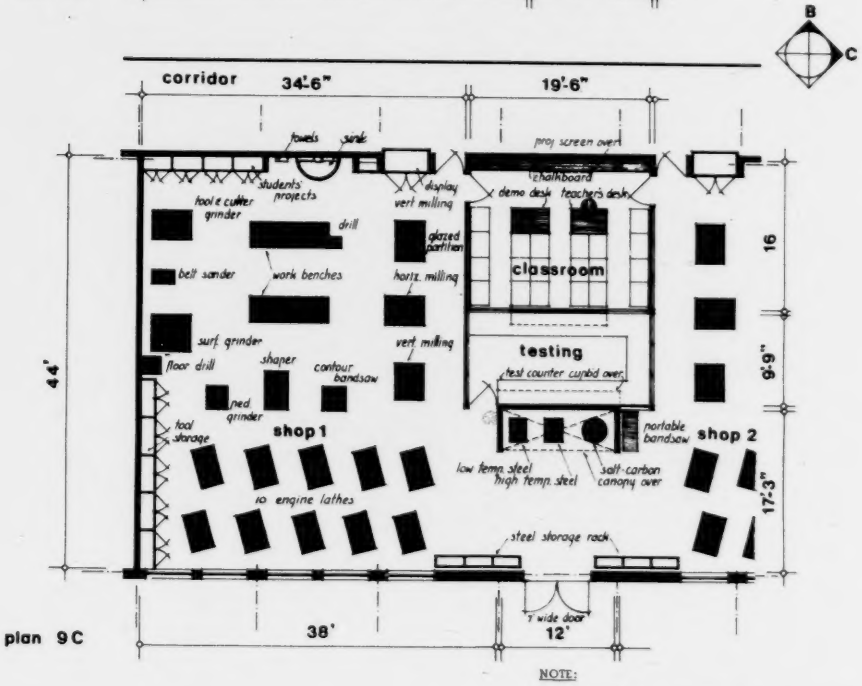



elevation A



# Machine Shop - Double (9B and 9C)



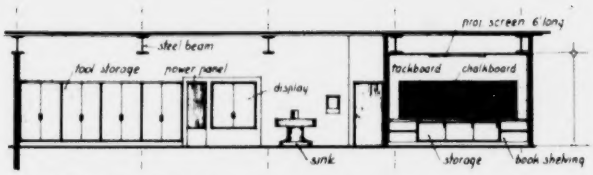




5 0 5 10 15

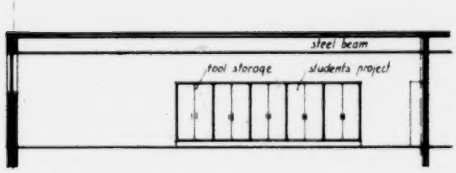
NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.

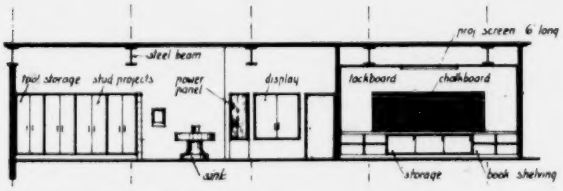
Machine Shop - Double (9D)



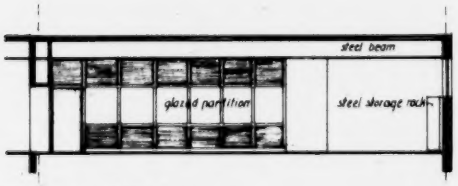

**elevation B, plan 9B**



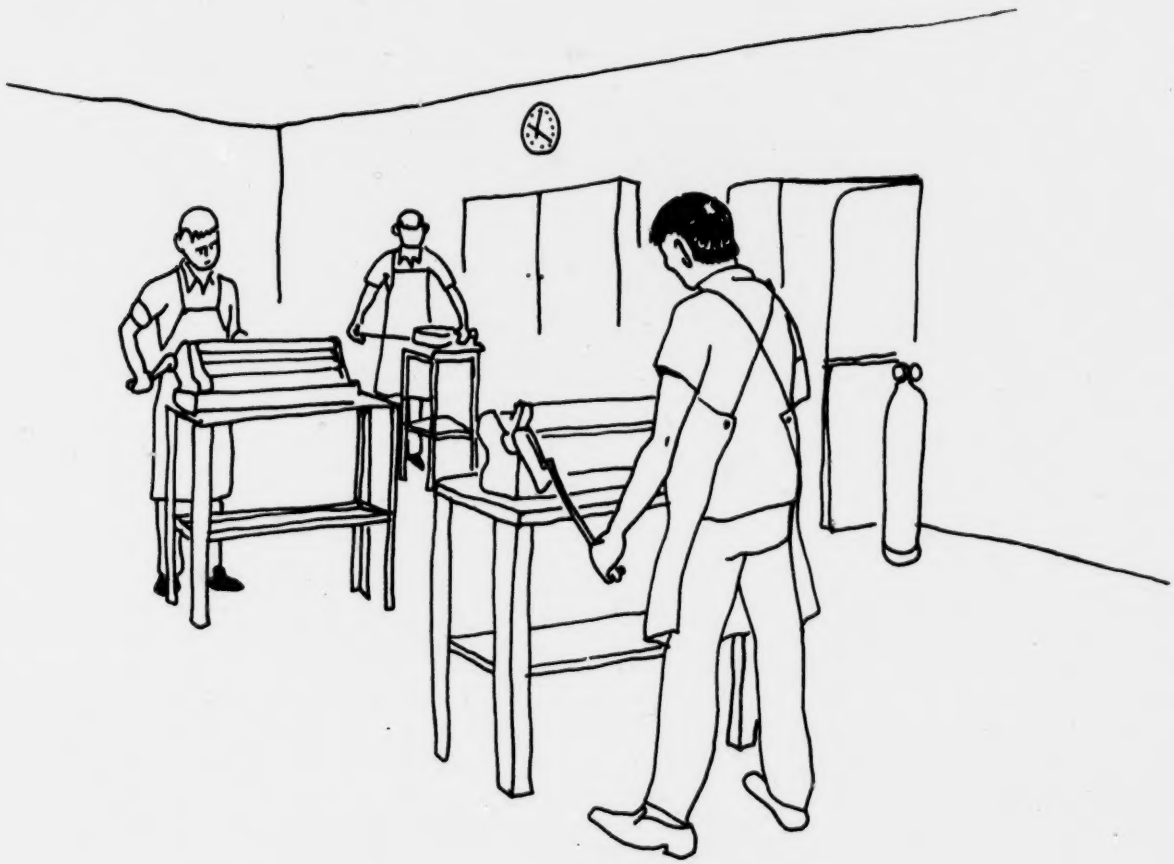

**elevation A, plan 9B**




**elevation B, plan 9C**




**elevation C, plan 9C**



## SHEET METAL SHOP

### FUNCTION

There are many branches of the sheet metal trade and the well-designed sheet metal shop makes provision for instruction in a wide range of the activities associated with sheet metal fabrication.

The content of the sheet metal course has changed considerably over the past decade and now includes the fundamentals of sheet metal practice, a study of hand and machine metal fabrication, fastening metals by seaming, soldering, riveting, and welding, a study of the principles of air movement, an introduction to air conditioning, and the fabrication and installation of ducted systems, as indicated in Curriculum R.P.27.

The machine method of fabrication makes it highly desirable that the students gain some experience in handling the heavier gauges of metal and in using power-operated sheet metal machines.

### LOCATION

The sheet metal shop is noisy and therefore should be located near other noisy areas, as far as possible from quieter sections of the school. Access to the outside of the building is generally desirable.

### FACILITIES

The area of the sheet metal shop shown is approximately 2,500 sq ft designed for 20 students.

In drawing 10 the layout area serves as a teaching area. The benches which should have two-in. laminated hard-wood tops, are frequently fitted for locked storage below the working area. There should also be a suitable number of outlets for the use of portable power equipment such as a shear and a nibbler.

Both power-operated and manual machines are shown on the plans as well as a construction area which provides space for larger projects. The provision of power machines allows the students to gain experience in many up-to-date techniques of metal fabrication.

The welding machines for the two arc-welding booths are to be stacked.

If it is desired to arc-weld in the construction area, and this will probably be the case, provision must be made to protect the eyes of the students working in other parts of the shop from the arc. This may be done by a portable barrier or screen of suitable design, so placed to prevent eye injury from flying particles of molten metal.

Two oxy-acetylene welding stations are shown on the plan with two cylinders on a welding cart so that gas welding may be done in the construction areas. The spot welder generally requires a water supply and a drain for cooling the electrodes.

A grid system at 4-ft centres mounted on the ceiling or slightly below is desirable for supporting typical ducted systems. Two exhaust fans are shown for the study of air movement and two units for the study of warm air systems and air conditioning.

The demonstration desk unit is intended to be a space-saver and to double as demonstration table and teacher's desk. Consequently, this unit should have a two-drawer filing cabinet, locking cupboards and drawers, and a knee space built in under the top.

### ELECTRICAL SERVICES

Convenient outlets, 110v, single-phase, should be suitably located about the room for use of portable tools. An outlet near the demonstration desk unit will be needed for the overhead projector, and one near the back of the teaching area for the slide or movie projector. In addition, electrical service will be required for the power operated equipment. The voltage, current, and

number of phases will depend on the electrical requirements of the equipment selected.

## STORAGE

There should be adequate space for projects in the cupboards which are usually divided horizontally into two equal sections and in the storage under the work benches. Storage may also be provided under the machine benches and the stakes may be stored on sloping panels under the stake bench. A metal shorts cupboard is not shown in drawing 10 but the metal shorts may be stored under the hexagon bench or a machine bench. Instruction Aids storage should be provided under the chalkboard.

## FINISHES

Floor: A concrete floor with a suitable hardener makes a satisfactory surface for the shop.

Walls: Concrete block or masonry construction is suitable and the walls should have a durable finish for easy maintenance.

Ceiling: The ceiling may require acoustic treatment particularly if there are classrooms above the sheet metal shop. This shop is a noisy area and acoustic treatment is highly recommended to keep noise within reasonable limits.

Woodwork: All woodwork should have a natural finish for easy maintenance.

## GENERAL

A clock, intercom, and emergency push button stations are not shown but are desirable. Emergency push button stations are recommended so that in an emergency, the electrical supply to all equipment may be disconnected.

## LIGHTING

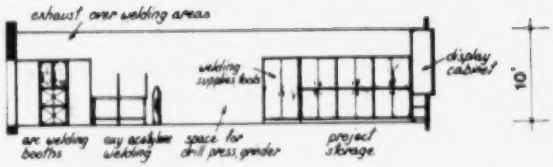
The lighting in the shop should provide illumination on the working surfaces to the level as prescribed in the National Building Code.

## HEATING AND VENTILATION

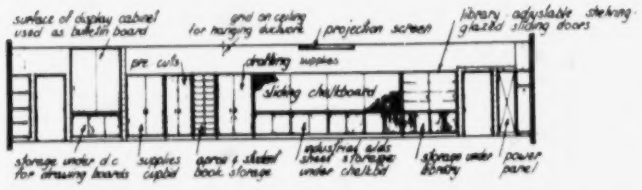
Generally, unit heaters make too much noise for the teaching area and other means of heating should be considered.

The areas which produce noxious fumes must be provided with an exhaust system.

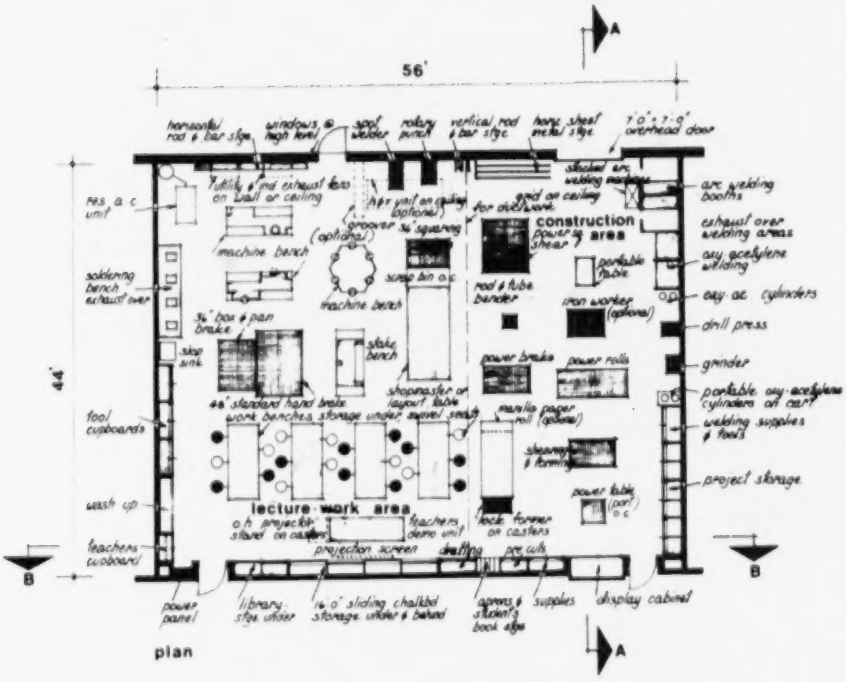
# Sheet Metal Shop (10)




elevation A


surface of display cabinet used as bulletin board
grid on ceiling for hanging artwork
projection screen
library adjustable shelving glazed sliding doors
pre cuts
drafting supplies
sliding chalkboard
storage under d.c. for drawing boards
supplies cupbd
games & student book storage
adjustable slate sheet storage under chalkbd
storage under library
power panel

elevation B




plan

NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.

## ELECTRONICS LABORATORY

### FUNCTION

The electronics laboratory suggested here is designed to provide space for student education in the subject theory while giving ample opportunity for experimental work and practical applications. Since many students will proceed to post-secondary education, teachers will likely give a broad introduction to basic electronic theory with a variety of applications from different segments of the electronics industry rather than concentrate heavily in any narrow field. At the same time, some students will enter employment directly and their needs have to be kept in mind. The electronics laboratory can serve both functions through suitable selection of equipment.

### FACILITIES

The electronics laboratory plan, drawing 14, includes features which have already proven their worth, and introduces innovations which should prove valuable in the future. The most important architectural characteristic is the partitioning of the total area into a number of separate functional spaces through the use of glazed partitions. This provides a good measure of sound insulation between sections while ensuring for the teacher a maximum of visual supervision.

The philosophy behind the adoption of the glazed partition is worth considering since a number of factors are involved.

It has become a common practice to have "teaching areas" within technical laboratories and shops, usually a close group of standard classroom desks. Many teachers feel that this provides more comfortable accommodation for a class during the formal lesson times than does the bench-seating accommodation. They also find that the simulated classroom environment is conducive to the atmosphere associated with the theoretical part of learning. The class is more closely grouped for discussion and group atmosphere is more easily established.

Regardless of the seating arrangement, however, some difficulties accompany either lessons or class discussions in the open laboratory area. Ceilings in technical shops often have poor acoustics. In many schools, students of two different grades may be in a classroom at the same time. This causes a difficult situation during the lesson period since the class not receiving the lesson inevitably causes distraction.

In addition, the current trend away from "lock step" class work and toward individual student progress suggests situations where part of any single class will be doing a variety of laboratory and practical work while others are doing seat work, research, or independent study in the classroom. To some degree, this has always existed in technical education.

For these reasons, it was decided to propose the partial separation of the teaching area by the use of glazed partitions. Glazing or screening was also extended to the other enclosed areas, except the storage room and the project area, to ensure a maximum of "see-through" and thus afford the teacher flexibility of movement while maintaining visual supervision.

### CLASSROOM

The facilities of the technical classroom can be similar to those of the standard classroom, particularly as regards lighting and sound-absorbing ceiling. It is intended to be an integral part of the laboratory. A suspended ceiling is not mandatory, but will improve the acoustics of the room.

The classroom should also include a desk, legal-size filing cabinet, library shelving, a permanent screen for slides, films, and projectuals, and a tv monitor for viewing broadcasts, video tape recording presentations, and closed circuit programs.

A chalkboard, approximately 16 ft long is required. The remaining part of the wall above the chalkboard will be an excellent place to provide tackboard for diagrams and display material.

LABORATORY AREA

Individual power supplies are desirable for the electronic part of the course even where junior electricity must be taught. Unit power supplies are considered preferable to the large central distribution unit patching panel and power supply.

The work benches should be served only with an adequate 115v, single-phase a/c supply. At least two separate circuits must be provided for each bench, with separate switching and overload protection at the main distribution panel. This will allow two students or student groups to work independently on the same bench. Since electronic experiments and practical tests frequently involve several instruments and other equipment which are a/c powered, a sufficient number of a/c receptacles per circuit should be provided. The equivalent of 10 single receptacles per circuit is suggested as a minimum, with a total current capacity of 20 amps per circuit. Receptacles should not interfere with the free bench-top space.

Each bench could be provided with separate co-axial cable terminals, properly capped, and suitable for tv frequencies. The work benches are shown in two different positions, one location with dotted lines.

The form of the benches has not been detailed. Some teachers prefer the plain flat-top bench while others may want some form of central shelf. In either case, it is intended that the common group of instruments, cathode ray oscilloscopes, volt-ammeters, signal generators,

and electronic voltmeters, would be conveniently stored.

A chalkboard of the horizontal sliding type is recommended with storage shelves behind. It is intended for special instructions related to practical and experimental work, improptu chalk-talks, etc.

TESTING AND INSTRUMENT STORAGE

This section is intended for testing and repairing equipment, particularly audio equipment where the glazed partition provides sound insulation and visual supervision. Infrequently-used electronic instruments would also be stored in this area. A suspended acoustic ceiling is necessary in this room.

PROJECT AREA

This area provides the teacher with some uncommitted space which can be used for a variety of purposes. The most likely use would be as a work area where one or more larger, long-range projects can be worked on. Such projects, usually involving more senior students, would likely be relatively large physically and complex electrically and consequently would take an extended period to construct, test and repair. It would be desirable to be able to leave them from day to day in their current states of assembly free from casual tampering by other students. The screen-type partition will protect the projects while letting junior students look at them.

Examples of such projects might be amateur radio equipment, intercom consoles, industrial control racks, electronic organs, and other large projects.

STORAGE ROOM

The storage room is intended for bulk storage of supplies such as small electrical and electronic components, and hardware, wire, tubes, transistors, and other expendable supplies.

PREPARATION ROOM

This room is a place for the teacher to prepare demonstrations, experiments, tests, etc., to mark students' work and projects, and to plan course development. The teacher will often need demonstrations consisting of a variety of interconnected equipment and instruments for use during a theory lesson. In the preparation room these demonstrations can be set up ahead of time on the mobile carts ("trolleys") and moved into the classroom. The teacher can also develop new experiments and demonstration circuits in this room at his leisure, leaving them partially completed without fear of accidental disassembly or tampering.

Glazed partitions are provided here to assist in the overall visual supervision. A curtain is suggested, however, between the classroom and the preparation room to provide some privacy when required, perhaps when two teachers use the laboratory at different times. One might prepare demonstrations in the preparation room during an on-call period while a lesson was in progress in the classroom.

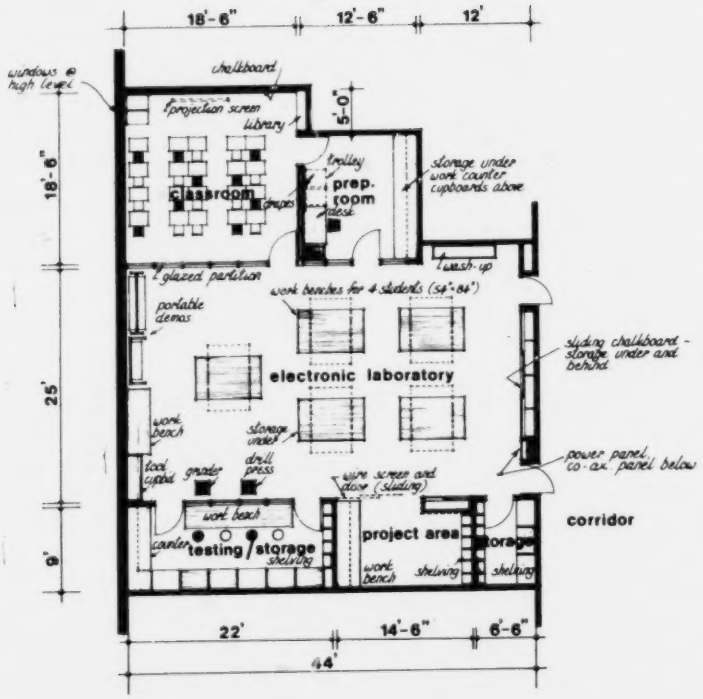
Floors: A wooden floor on sleepers is practical. Small sections that lift up will allow changing of outlets spaces for the power.

Walls: Painted concrete blocks are suitable.

Lighting: Requirements of the National Building Code should be observed.

Wash-up: A wash-up space for the students should be provided, preferably close to the exit.

# Electronics Laboratory (14)




plan

NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.

## ELECTRICAL SHOP

### FUNCTION

The well-designed electrical shop should provide adequate facilities for the study of the two divisions of applied electricity; namely, electrical installation and maintenance, and electrical theory and test.

Installation and maintenance includes a study of different wiring methods, typical motor control circuits and the regulations governing industrial, commercial, and residential electrical installations. Electrical theory and test includes study of the theory underlying electrical circuits, electrical instruments, electrical equipment and machines.

Applied electricity is a popular subject in secondary schools. It may be studied in one room, as shown in this booklet, under the direction of one teacher, or it may be studied in two or more rooms (shops and laboratories) under the direction of two or more teachers.

The success of a course in applied electricity is dependent on the provision of adequate facilities to permit a "learn-by-doing" approach, with each student gaining considerable "hands-on" experience.

The two electrical shop plans in this booklet are not intended to show "ideal" arrangements for all conditions but may generate ideas for planning the electrical shop.

### LOCATION

This shop should be near other relatively quiet technical areas. Due to the relation between electricity, electronics, electrical drafting, and industrial physics, it is desirable that these teaching areas be located in the same general area.

### FACILITIES

Each of the electrical shops shown has an area of approximately 2,100 sq ft and is designed for 20 students. On drawing 15 the teaching and experimental areas are combined, while on drawing 15A they are separated. The separate classroom has several advantages. It permits good teaching conditions to be achieved, allows effective use to be made of audio-visual aids, and provides a quiet area with comfortable seating for the students to study or to do research. The glazed classroom partition isolates the teaching area from the noise of the shop but permits visual supervision.

The motor-generator units are not specified but the space shown on each plan is adequate for the equipment required for studies at the secondary school level. Some teachers may prefer a number of large motor-generator units, others may prefer a larger number of small (fractional horsepower) motor-generator sets or a combination of large and small sets. With a relatively large number of motor-generator sets the experimental groups may be small and the students may gain satisfactory experience in testing machines.

When tests are performed on the generators or motors, portable instruments are commonly used. In this case, tables or trays for the instruments near the motor-generator sets may be desirable.

In addition, its use as a work area, the work bench is intended to provide external and internal conduit storage and a partitioned locker for storing the commonly used sizes of conduit. There can also be facilities for outside storage of conduit on brackets on each side of the bench unit. The bench should have at least four duplex, 120v, single-phase receptacles for the use of portable equipment. A grinder, a $\frac{1}{2}$ in. drill press, one or two pipe-vises for cutting and threading conduit, and two machinist's vises could also be mounted on the bench. This bench should be approximately 10 ft 6 in. to accommodate a full 10 ft length of conduit.

The demonstration-desk unit is intended to be a space saver and to serve as a demonstration

table and a teacher's desk. Consequently, this unit should have a two-drawer filing cabinet, locking cupboards, drawers, and knee space built in under the top. Where space is available, a separate teacher's desk and a standard demonstration table may be preferred.

ELECTRICAL SERVICES

The following electrical services are usually required for the demonstration-desk unit and for each two-student station at the experimental benches:

Direct current -- variable low voltage
Direct current -- 0-150v
Single-phase -- 120v, 60 hz
Three-phase -- 120/208v, 60 hz

Usually, adequate three-phase services are available for experimental work by the senior students if three-phase voltage is available at alternate two-student stations. A three-phase 120v supply may be desirable for experimental work on star and delta connections.

A central power supply unit is usually used for the 0-150v d/c supply. While the central power unit may also be used for the low voltage d/c supply, consideration should be given to the use of portable low voltage d/c units or low voltage supply units built into the experimental benches and the demonstration-desk unit.

The use of the low voltage supply units allow greater flexibility for experimental work and eliminates the necessity for following a lock-step procedure.

Three-phase, 208v, 60 hz, and 0-150v d/c are usually required for the motor-generator area. The current rating of the supplies required will depend on the current rating of the equipment selected.

The electrical services to the experimental benches, the demonstration-desk unit, and the motor-generator sets will normally be controlled through circuit breakers or switches and fuses from a distribution panel(s). These services may be directly wired to the benches and machines or "patched through" by means of cords and colour-coded terminals. With large units, spare lines, possibly six, looped between the motor-generator sets may be desirable in order that one or more motor-generator sets may be connected to other motor-generator units or to equipment adjacent to another m/g set.

The soldering table shown on drawing 15, if required, will need 120v, single-phase receptacles for the use of soldering irons. Receptacles should also be provided on the utility bench, drawing 15A for the use of portable equipment. The soldering table should have a top of suitable heat-resistant material, and holders for soldering irons should be designed for adequate heat dissipation.

The power-supply unit which provides the distribution panel and the rotating equipment may be a console or can be wall-mounted in a suitable enclosure. The wall-mounted units should be front-opening for ease of servicing. Free-standing distribution cabinets are available and may be mounted out from the wall to provide easy access for servicing from the rear. For safety, access doors to the above cabinets must be the locking type.

The motor control area should be provided with a plywood panel or other suitable surface for ease of mounting control equipment and electric motors. Portable motor control units may be used to increase the number of work stations.

Three-phase, 120/208v, 60 hz electrical service is required for the motor control area. D/c may also be desired. A single-phase, 120/240v, three-wire supply is generally required for the wiring area.

## STUDENT BENCHES

Student benches should have tops of laminated hardwood (birch or maple) or plywood with a replaceable sheet of suitable material on the surface. These benches are usually provided with a unit which contains receptacles and/or colour-coded terminals for the electrical services. Multi-range ammeters and voltmeters are frequently mounted in these units.

Stools for the benches in the experimental area, drawing 15A are shown dotted, since they may not be required. Stools are required for the teaching area, drawing 15. They can be the swing-out type mounted on the bench.

## PREPARATION ROOM

The preparation room is intended primarily for the use of the teacher in preparing teaching materials or setting up demonstrations. The "trolley" permits the demonstration to be set up on this mobile cart, pre-tested, and brought out when required. The services required in the preparation room will depend on the activities to be carried on in it, but four electrical outlets (two d/c and two a/c) along the work counter should be adequate. This room should have locks.

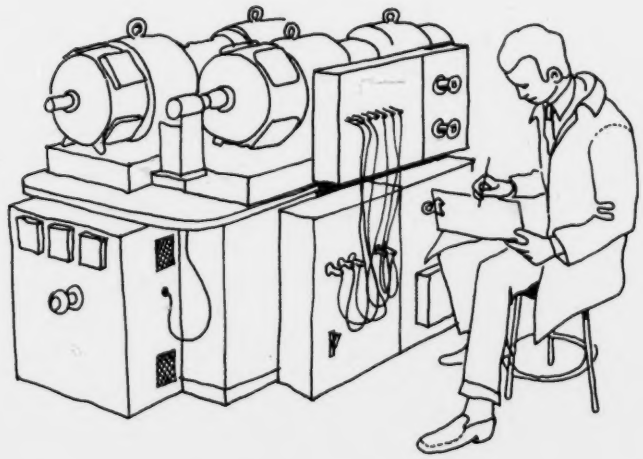
Providing the normal functioning of the room is not interferred with, some portable equipment may be stored in the preparation room. But it should not be used primarily as a storeroom.

## STORAGE

The storage room is used for storing electrical components, electrical fittings, expendable supplies, and parts for equipment under construction. Day-to-day supplies would be kept in one or more cupboards in the shop and the students would normally not have access to the storeroom.

Provision should also be made for storing lamps and used wire. A wall-mounted lamp rack and a portable wire bin may be considered adequate. Otherwise, a cupboard should be arranged for this purpose. Adjustable shelving should be used in storage cupboards.

The portable units shown in the preparation room represent variable resistance and reactive loading devices. The reactive loading devices may be separate inductive and capacitive units or combined inductive-capacitive units. Instruction Aid storage should be provided under the chalkboard. There should be locks for the storage space under the student benches.



## FINISHES

Floor: Wood may be preferable, but resilient tile is a satisfactory floor finish for electrical shops. A floor duct system may be desirable to allow for future expansion and for changes in the installation. A concrete floor is generally not recommended where test instruments are being used.

Walls: Concrete-block or masonry construction is suitable and the walls should have a durable finish. It may be necessary to give acoustic treatment to the three masonry walls if the classroom is close to the noisy area.

Woodwork: Hardwood with natural finish is suggested in the interests of easy maintenance.

## GENERAL

A transformer demonstration-bench is shown on drawing 15 but portable transformers may be used.

Black-out curtains are required in the teaching area for the use of projection equipment.

Paper towel dispensers are required and should be located near the sink where the students can wash.

Note: Emergency push-button stations located at suitable places in the shop are recommended so that, in case of an emergency, the electrical supply to the shop equipment may be cut off by pressing any of the emergency buttons.

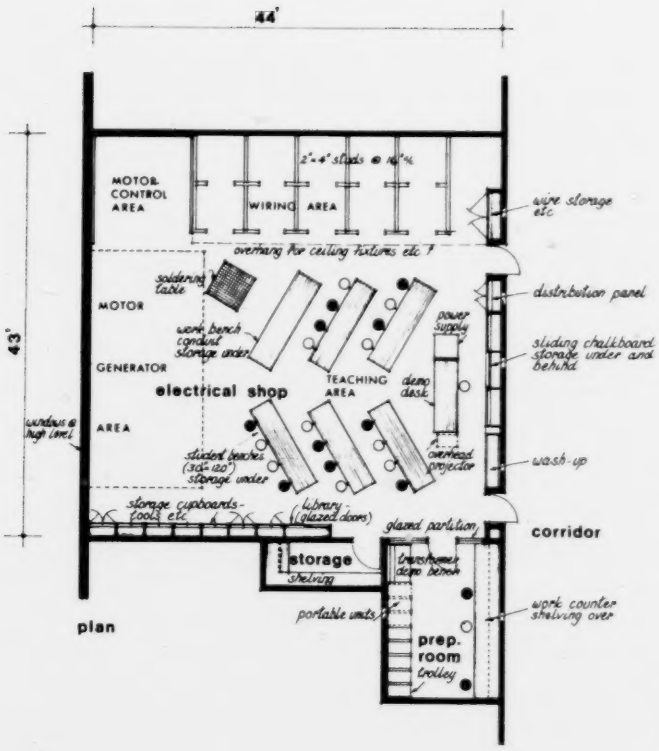
## LIGHTING

The lighting in the shop area should provide illumination on the working surface as prescribed in the National Building Code.

## HEATING

Unit heaters are not satisfactory for the electrical shop because of their inherent noise.

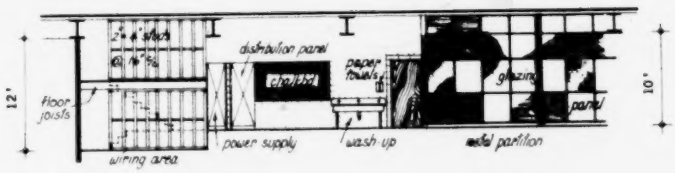
# Electrical Shop (15)



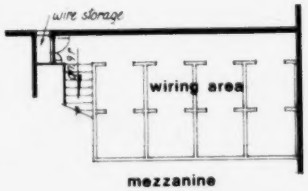

NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.

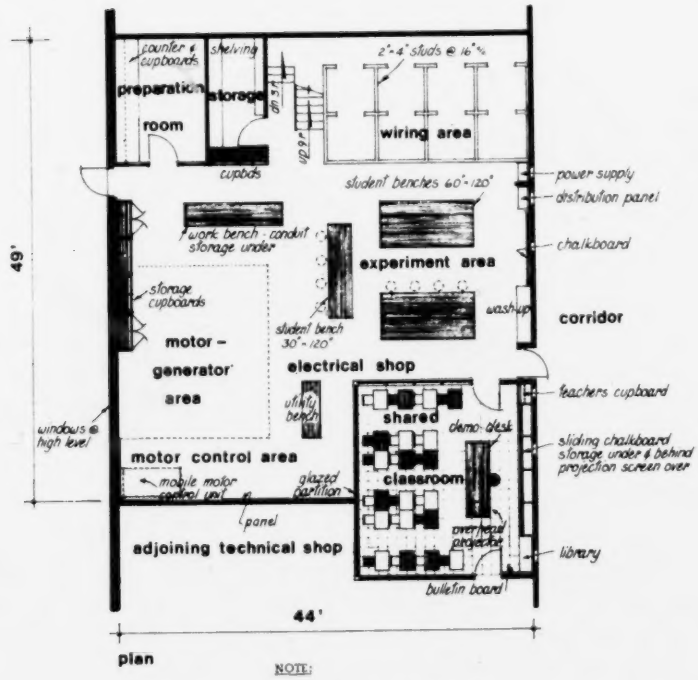
# Electrical Shop (15A)




elevation A




mezzanine




plan

5 0 5 10 15

NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.

## REFRIGERATION, AIR CONDITIONING AND HEATING

### FUNCTION

Rapid technological changes indicate that refrigeration, air conditioning and heating can no longer be considered as three separate units of our industrial program. Integration and interdependence of technology and skill has provided the background material for the accompanying plan.

Provision has been made for the teaching of 20 students with emphasis on an environmental approach. The layout permits maximum flexbility in teaching techniques. Instruction in basic fundamentals, system analysis and circuit layout can be offered under ideal conditions. Emphasis may be placed on design and servicing or installation and maintenance, or both, depending upon the student's goal--employment after high school or further education.

### LOCATION

Because of its relationship to the electrical, welding, machine and sheet metal shops, it is preferable to locate this shop adjacent to, or in close range of these shops. Interconnecting doors, however, are not recommended.

### FACILITIES

A general shop area of approximately 1,060 sq ft is required by grades 9 and 10 for instruction in basic refrigeration, air conditioning, and heating operations.

The work area should be designed preferably with the work benches centred, surrounded by the trainer units for refrigeration and heating.

The two work benches, each 4 x 12 ft, surfaced with metal and equipped with six combination bench vises, are designed primarily for use by the junior classes which are involved largely in bench operations such as cutting, flaring, soldering, brazing and threading of copper tubing and iron pipe. The work benches should be designed with lockable storage cabinets underneath, one for student projects, the other for storage of supplies and metal scraps.

A test bench with a laminated wood top is required for use in electrical, pressure, and temperature testing, equipped with a low rear console on which 110 and 220v outlets are available as well as pressure gauges and other services. Under this bench, a row of drawers and cupboards should be provided for storage of portable test equipment. Tool cabinets containing major common hand tools for pipe and tubing work, should be located adjacent to the work benches. Another tool cabinet, designed for storage of trade tools used for service and installation of refrigeration equipment, is best located on the opposite wall of the shop.

A large exhaust hood located on the exterior wall and designed to vent fumes from fuel oil, parts washing, welding, brazing, refrigerant purging, etc., is placed 7 ft above floor level so equipment and work tables can be placed under the hood. The students' benchwork in grades 11 and 12 also includes repairs and servicing of equipment.

### MAJOR SHOP EQUIPMENT

Refrigeration Trainers: These units are designed to carry condensing units and evaporator assemblies for use in domestic and commercial refrigeration systems. They should be of steel construction and of varying heights with the work top 24 to 30 in. above the floor. The units should be constructed with large swivel casters and have drawer and cupboard space below for the storage of system components. Units should be equipped with rear panels for mounting of refrigerant line equipment and controls. Above the panels, provision should be made for the mounting of various types and sizes of evaporators using a system of slotted angles which will provide for maximum flexibility. Approximately 10 such trainers are required.

Refrigerated and Air Conditioning Appliances: Shop equipment should include a sample of the following appliances:

single temperature domestic refrigerator

two temperature refrigerators with static evaporators

two temperature refrigerators with forced convection

"no-frost" evaporators

"chest" type domestic freezer

"window"-type room air conditioners (environment control room is equipped with double hung windows designed for these units). One unit should be equipped for reverse cycle heating.

portable room humidifier and dehumidifier

## CLASSROOM

This layout is approximately 490 sq ft and is equipped with 14 moveable lecture-type tables and seats (left and right hand) and with six drawing tables, a teacher's demonstration desk with 2 in. laminated wood top and drawers with moveable partitions for storage of parts and fittings used for demonstrations in the classroom. The demonstration desk should be supplied with 110-220v power and compressed air. In addition, a storage cabinet for students' drawings, library and magazines shelving, Instructional Aid Sheets storage under chalkboard and bulletin-board, and a legal size filing cabinet or file drawers built in a demonstration unit should all be provided.

Acoustical suspended ceiling 8 ft 8 in. is preferable in the classroom. Glazed partitions 3 ft 6 in. above floor level are recommended for easier supervision of the activities. Convection heaters are recommended for the classroom. Unit heaters are too noisy.

A day-projection screen should be provided, recessed in the ceiling for an overhead or other projector. Outlets of 110v, 115 amp will be required to run the projector. Provision for future tv installations should be considered.

## MECHANICAL EQUIPMENT ROOM

Approximately 410 sq ft are required to house residential forced air, gas and/or oil-fired heating equipment, year-round air conditioning systems for residential, commercial and industrial, and equipment for complete environment control. It is important that proper ventilation is provided for the removal of fumes and odours.

Provision for tool storage with shelving partly open and partly lockable is necessary for the storing of hand tools and other special equipment used by senior pupils.

## HYDRONIC HEATING SYSTEM

This system is designed to operate four hydronic circuits, each with its own circulator. These include:

a standard residential single-pipe "monoflo" loop with 8-in. baseboard units

a hot water heating coil for the package air conditioner supplying the classroom

hot water supply for the environment control system

a spare circuit for use in the construction of two-pipe system for unit heaters or other hydronic equipment.

The boiler should provide 80,000 to 120,000 btu/hr and be equipped with hydronic-type flow meters and thermometers on each circuit. Such a system provides maximum flexibility with regard to layout, installation and servicing of hydronic equipment.

## FORCED AIR RESIDENTIAL HEATING SYSTEM

This system makes use of a standard high-boy furnace and conventional perimeter duct system to heat the environment control room.

A second low-boy furnace is installed without duct work. This furnace should use simple bolted

construction so that it may easily be torn down and reassembled by the pupils.

YEAR-ROUND RESIDENTIAL AIR CONDITIONING SYSTEM

This system uses a gas-fired high-boy furnace with plenum coil, three-ton air-cooled condensing unit, power humidifier and residential electronic air cleaner to furnish year-round residential air conditioning. It is equipped with a perimeter-type system and also is terminated in two ceiling diffusers in the environment control room.

YEAR-ROUND COMMERCIAL AIR CONDITIONING SYSTEM

This system uses a three-ton package air conditioner with hydronic heating coil and mechanical atomizing humidifier. It is designed to condition the classroom area using an overhead duct system and ceiling diffusers with high side wall return. The unit should be piped for use on city water or with a small five-ton cooling tower located on a concrete pad outside the shop. This tower could also service the industrial system as required.

INDUSTRIAL AIR CONDITIONING SYSTEM

This system is designed as a chilled water system using a fan coil unit equipped with

pre-heat coil
mixing box
viscous impingement filters
spray water humidifier with recirculating pump
chilled water cooling and dehumidifying coil
re-heat coil

The system should be ducted to the shop area and to the environment control room. It should be fully instrumented with temperature, pressure and flow instruments and be operated with a pneumatic control system which incorporates current control practices.

The water chiller may also be used along with the hydronic boiler to supply a year-round hydronic terminal unit located in the environment control room. This latter unit could be piped up as a two, three or four-pipe system as part of the student program. The water chiller should be piped for operation on city water or from the water tower as required.

THE SUPPLY AND EXHAUST VENTILATION SYSTEM

This system is designed to supply the mechanical equipment room and the environment control rooms with the required ventilation as well as to provide the ventilation air for the classroom and industrial system. It consists of a small heating and ventilating unit operated from the school's central hot water or steam system, a conventional exhaust fan and recirculation system.

PREPARATION AND STORAGE ROOM

Approximately 200 sq ft in the layout are required for storage space for parts, equipment, components, fittings, and instructional materials. A desk and legal size filing cabinet are necessary for the teacher's use. A work bench and two mobile tables for moving equipment from this area to classroom or general shop area are also needed.

ENVIRONMENT CONTROL ROOM

A closed-in area of approximately 130 sq ft is suggested so that conditions of temperature, humidity, air circulation and cleanliness can be varied and the performance of the various appliances, as well as the central systems located in the equipment room, can be assured. The room is required to provide a terminus for the heating and air conditioning services from the equipment room, as well as to house some of

the many small refrigeration, air conditioning and heating appliances and room units.

WALK-IN REFRIGERATION BOX

Approximately 100 sq ft are required for the installation and testing of refrigeration equipment including water and air-cooled condensing units and evaporators, operating in both commercial and low temperature ranges.

This area can be constructed with provision for four evaporators and matching condensing units located as per plan. Two condensing units located at each side of the door may be water cooled. Two mounted above the box may be air cooled. Such a layout will provide facilities for design, installation and testing of a piping system with evaporators both above and below the condensing unit. The following evaporators may be used.

commercial temperature forced-air, ceiling mounted, with timed cycle defrost

low temperature forced-air, ceiling mounted, with timed electric or hot gas defrost

commercial temperature static fin coil, ceiling mounted, with timed cycle defrost

low temperature plate stand, floor-mounted manual defrost

The box should be constructed with four inches of insulation in accordance with current trade practice and should be equipped with wall and ceiling sleeves to provide for piping installation. $1\frac{1}{4}$ to $1\frac{1}{2}$ in. slotted or predrilled angles bolted to the ceiling on the sides and rear of the box to facilitate coil hanging. The refrigeration equipment should be installed as part of the shop program with only electrical and drain services supplied.

FINISHES

Vinyl asbestos tiles on a concrete sub-floor is preferable in all rooms except the mechanical equipment and the walk-in refrigeration box where a concrete floor sloping to floor drains is suggested.

Walls: Concrete block is suitable and should be finished with enamel or epoxy paint for easy maintenance.

Ceilings: The general shop area, preparation and storage room, mechanical equipment room, and environment control room do not require any special ceiling. A painted roof slab is sufficient. The classroom ceiling, however, should be suspended acoustic approximately eight ft eight in. high. The walk-in refrigeration box requires a suspended insulated ceiling.

LIGHTING

Windows can be installed in the general shop area as long as the window sills are no lower than seven ft above the floor. The National Building Code minimum of 70 ft candles is a desirable lighting level. Fluorescent light fixtures are preferred. The rows of fixtures should be controlled from three positions--one at the entrance to the general shop area from the mechanical equipment room, one at the classroom entrance, and one from the outside double doors leading to the general shop area. In the classroom at tabletop level, 85 to 100 foot candles are adequate for drawing purposes.

HEATING

A silent heating system is required in the teaching area and quiet two or three-speed unit heaters in the work area.

VENTILATION

Due to the possible presence of refrigerant gases and soldering fumes there should be at least six complete air changes per hour. There should be a vent near the floor to vent freon gas.

SERVICES

Electrical: Power panel near the hall doors should supply 100 amps, 208v, three-phase, four-wire service. Master push button, key-operated, should control all power. One remote push button might be located near the walk-in refrigeration box.

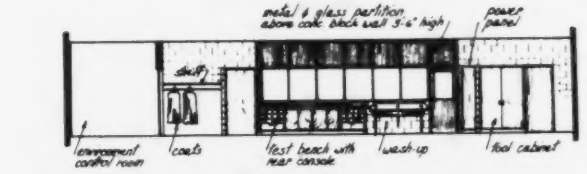
Distribution of electrical power should be in the form of several triple-purpose outlets located as shown on the plan. These should supply 120v, single phase, duplex receptacles with U ground; 208v, single phase, tandem duplex receptacles with U ground; 208v, three-phase, polarized receptacles with U ground.

Note: Twist-lock receptacles are not recommended.

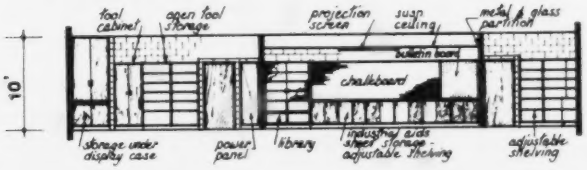
Air: Several outlets as indicated on the plan, with a pressure of 150 psi are recommended. A pressure regulator for reducing pressure should be connected to one outlet, with fittings of the automatic shut-off type (snap action) when hose is disconnected. The total capacity of air for the room can be supplied by a three horsepower compressor. There is no need for vacuum lines in this room.

Water: Cold water outlets are required near the walk-in refrigeration box and large air conditioning unit. Wash-up facilities with hot and cold water is needed. A four in. drain with clean-out is also required.

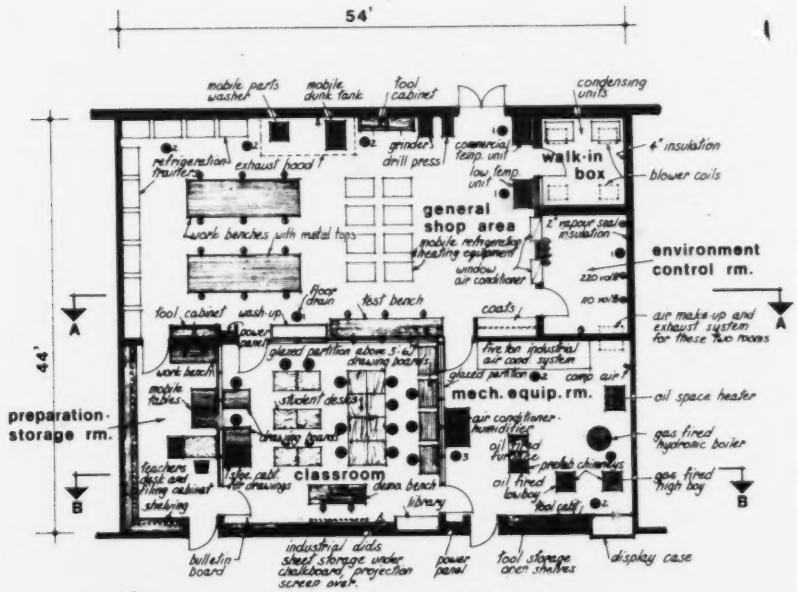
## Refrigeration, Air Conditioning and Heating Shop (16)




elevation A




elevation B




plan

- ⊖ 110 volt electrical outlet.
- ⊖ 220 volt electrical outlet.
- ● 1 floor drain.
- ● 2 ½" city water supply and drain.
- ● 3 ¾" city water supply and drain.

NOTE:

The equipment shown provides for a wide variety of programs. The individual program for this shop, as determined by the school board, will establish the actual equipment to be purchased.